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Large Corliss Engine in Cement Mill Service

THE LARGEST LOW-PRESSURE CYLINDER IN ILLINOIS ON A CORLISS ENGINE

AT DICKINSON, ILL., about 7 mi. out of La Salle and located along the C. B. & Q. Railroad, are the large cement mills of the Marquette Cement Mfg. Co. During the spring of 1914 there was installed in the 8000-hp. power plant of this company what is claimed to be one of the largest Corliss engines in the state of Illinois. This engine, which was built by the Fulton Iron Works of St. Louis, Mo., and is shown in the accompanying illustration, is of the horizontal, heavy-duty, cross-compound condensing type, having cylinders 36 and 76 in. in diameter and a stroke of 54 in.

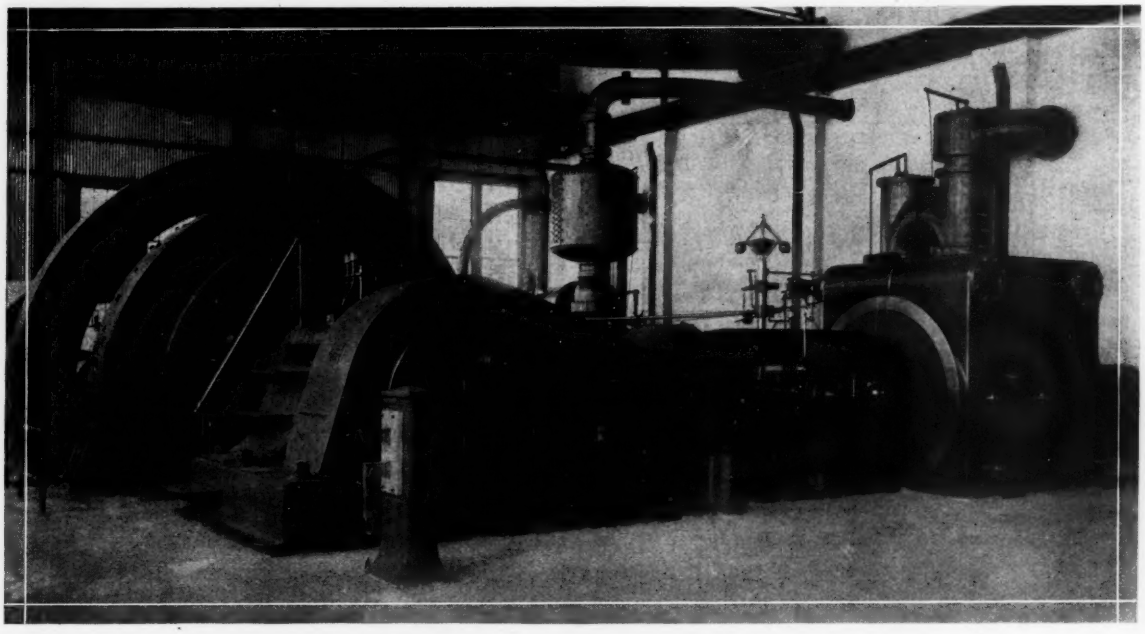

FIG. 1. LOW PRESSURE SIDE OF ENGINE; MARQUETTE CEMENT MFG. CO.

At a boiler pressure of 150 lb. per sq. in. and a receiver pressure of from 10 to 12 lb. per sq. in., and at a speed of 90 r.p.m., the engine, which drives a 2000-kw. Allis-Chalmers direct-current generator, will develop 3000 hp. The main crank shaft, which is 26 ft. in length and 30 in. in diameter at the center, weighs 45,000 lb., the flywheel of 8 sections weighs 155,000 lb., the low-pressure cylinder 64,000 lb., while the weight of the complete engine is approximately 310 tons. The foundation is of concrete, with dimensions as shown in cut.

Seventy-six inches is an unusually large diameter for an engine cylinder, and it is this feature of the unit which makes it interesting. While the piston rod on the low-pressure side is 11 in. in diameter, a tail-rod of the same size is provided to relieve the cylinder walls of all unnecessary wear, the cylinder being lubricated by a system of forced feed pumps. Each end of the cylinder is provided with a counterbore 76¼ in. in diameter and 12 in. in length, while over-all dimensions, as shown in Fig. 3, are, length, 7 ft. 7¾ in.; height, 10 ft. 4⅛ in.; width, 8 ft. 4½ in.

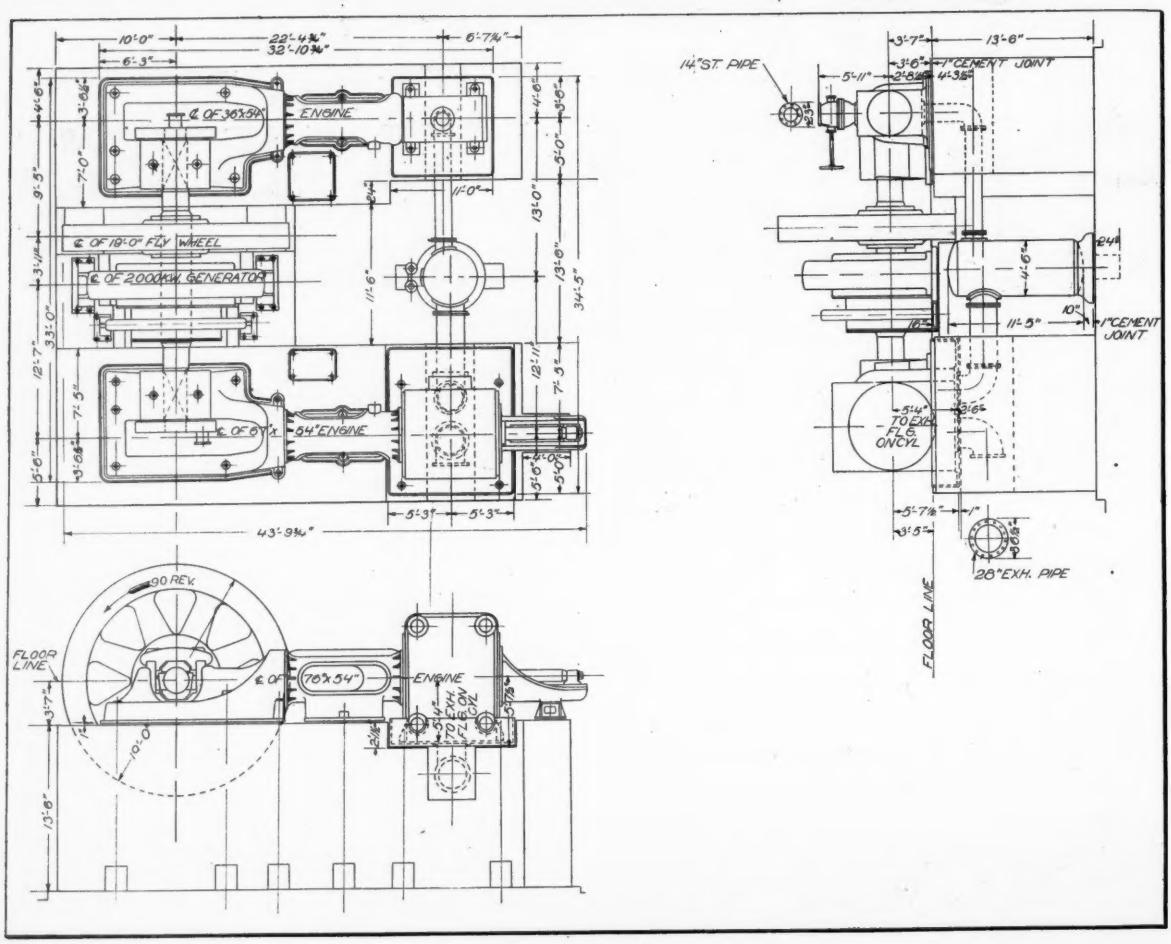

FIG. 2. ASSEMBLY DRAWING OF ENGINE

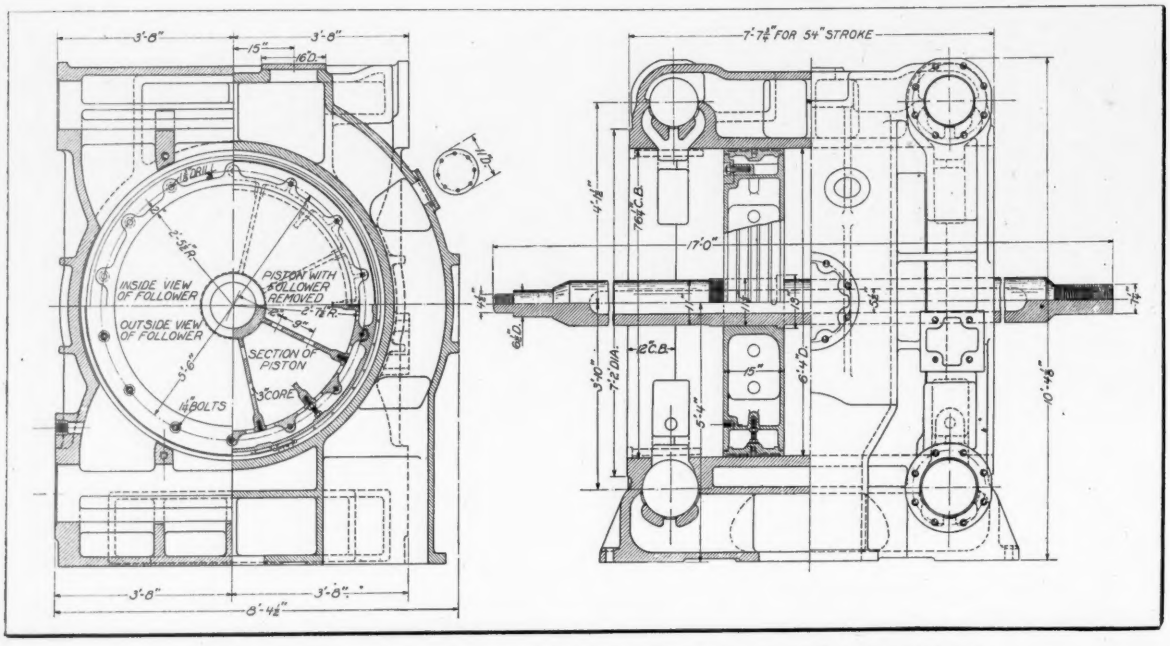

FIG. 3. SECTIONAL VIEW OF L. P. CYLINDER WITH PISTON, PISTON AND TAIL-ROD

Figure 2 is an assembly drawing of this engine showing plan and elevation, while Fig. 3 is a sectional view of the low-pressure cylinder with piston, piston and tail-rod. It will be noted from these prints that while the piston rod is 11 in. in diameter, it is hollow throughout almost its entire length, with an internal diameter of 5½ in.

While it would seem that if the trend of present day power plant practice had been followed, a steam turbine would have found a place in this plant instead of this reciprocating unit, it was found after a careful study of conditions that, due to the nature of the load, the Corliss engine would have a greater over-all economy.

General Equipment of Plant

Remaining equipment contained in the engine room of this plant consists of 4 cross-compound Corliss engines direct connected to 250-v. direct-current generators.

Five of the panels of the switchboard are generator panels and carry the necessary knife switches, field rheostats, I T E circuit breakers, Weston ammeters and voltmeters and Thomson direct-current integrating wattmeters. Due to the great amount of current carried, the circuit breaker used in connection with the 2000-kw. unit is of the I T E motor-operated type. Adjacent panels are used for the control of the separate feeder lines and are equipped with a double row of circuit breakers, each vertical set being rigidly connected by a tie rod, so that in case of an overload both sides of the circuit are opened and when closed both sides are closed simultaneously.

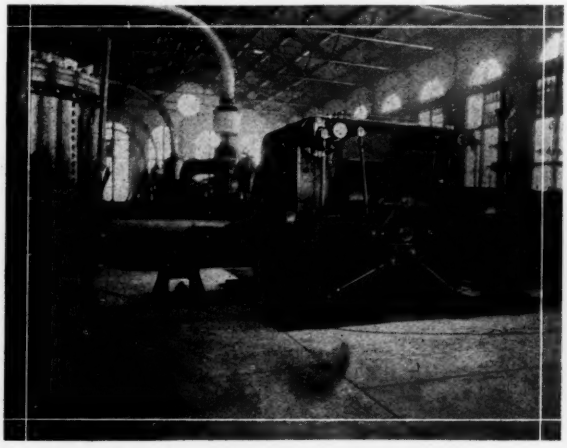

FIG. 4. LOW-PRESSURE VALVE GEAR

Steam is fed to the engines at a pressure of approximately 150 lb. from a steam header running along the boiler room wall. This header is, in turn, supplied by 6 batteries of 2 410-hp. Stirling water-tube boilers, each equipped with Green chain-grate stokers burning Illinois coal. This coal is fed to the stoker hopper by means of chutes leading from an overhead bunker located in front of and above the boilers.

As the power house is located at the foot of a steep bluff, a spur track of the Chicago, Milwaukee & St. Paul Railroad has been built directly over the bunkers so that the coal may be readily dumped therein and delivered to the furnaces with little if any further handling.

Lignite as Fuel

Supply Available, Constituents, Furnace Requirements. By Traveler

SOME engineers declare lignite to be an idea fuel, others say it is only so much dirt, not worth wasting time over. And each has some grounds of justification.

Where there is plenty of boiler capacity, liberal grate area, with a steady load, lignite is very satisfactory. In plants where the boilers are loaded to or above rating, where the draft is poor, or sudden change of load occurs, it is as an engineer from the East, who has charge of the latter kind of plant says, "Just a notch ahead of Rhode Island coal." Yet the great abundance of this

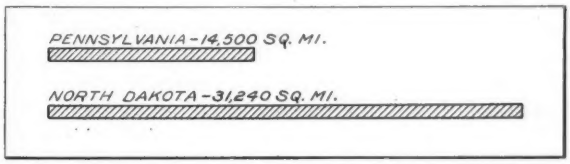

FIG. 1. COMPARISON OF COAL AND LIGNITE AREAS

fuel, in a section where other fuels are scarce and high in price, entitles it to consideration, if it has no other qualities, which I mention it has.

The principal workable deposits of lignite are found in the northern Great Plains region, which occupies the western half of North Dakota, the northwestern part of South Dakota, and the eastern half of Montana. In this territory are many thousand square miles, underlaid with beds from 5 to 30 ft. thick, while I have heard of, though I never saw a vein, with a thickness of 80 ft.

In the state of North Dakota, alone, according to the United States Geological Survey, there are 31,240 sq. mi. underlaid with workable deposits. There are deposits in other states also, notably, Texas and California.

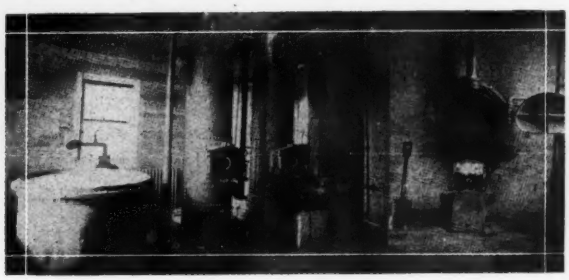

FIG. 2. EXPERIMENTAL PLANT AT NORTH DAKOTA UNIVERSITY MINING STATION

It is with the former field, and especially along the line between North Dakota and Montana, with which this article deals.

That some idea may be formed of the magnitude of these deposits, the coal bearing area of Pennsylvania and North Dakota are here shown graphically.

The writer came West 3 yr. ago, without prejudice, determined to take lignite on its merits. After this length of time spent in close association with, and use of it as a fuel for both domestic and power purposes, we confess that we are willing to be classed as a booster

for its more general use. Under suitable conditions, and where the furnaces have been designed for this fuel, results have been secured which compare favorably with other coals. The high moisture content carried, and rapid deterioration when exposed to the atmosphere, confine its use to territory adjacent to the mines.

It is much used as a domestic fuel, freedom from soot and smoke more than compensating for slowness to kindle. It will also hold fire longer than soft coal.

		Thickness, ft.	Moisture	Volatile	Fixed Carbon	Ash	B.t.u.'s
*Jennison Coal Co	Fairview, Mont.	7	35.61	28.94	32.27	3.8	7420
Miles Outcrop	Custer Co., Mont.	29	35.51	26.75	28.87	8.87	6363
Snyder Mine	Glendive, Mont.	6.5	34.55	35.34	22.91	7.2	7090
Breuggerrs Mine	Culberson, Mont.	9	43.16	22.03	28.99	5.82	5999
Open Pitt	Beach, N. D.	10	35.72	31.88	23.54	8.86	6368
Medora Mine	Medora, N. D.	9	38.45	28.02	27.84	5.69	6806
Russell Outcrop	Sand Creek, N. D.	43.5	43.78	26.07	26.33	3.82	5972
Outcrop	Sentinel Butte, N. D.	21	29.78	32.31	31.35	6.56	7224
Scranton Mine	Scranton, N. D.	11	41.43	23.86	28.45	6.26	6241
Wilton Mine	Wilton, N. D.	13	40.55	27.05	27.37	5.05	6644
U. S. Recl. Service Mine	Williston, N. D.	7	36.60	32.93	25.69	4.78	6824
*Lignite Briquettes, N. Dak. U	Hebron, N. D.		06.00	05.00	80.00	12.5	12500

	Illuminants	Carbon Monoxide	Hydrogen	Ethane	Methane	Nitrogen	Oxygen	Carbon Dioxide	B.t.u. per cu.ft.
Lignite Gas, unpurifed, at Hebron substation	2.45	18.39	43.96	0.51	15.44	5.04	1.32	12.80	497.6

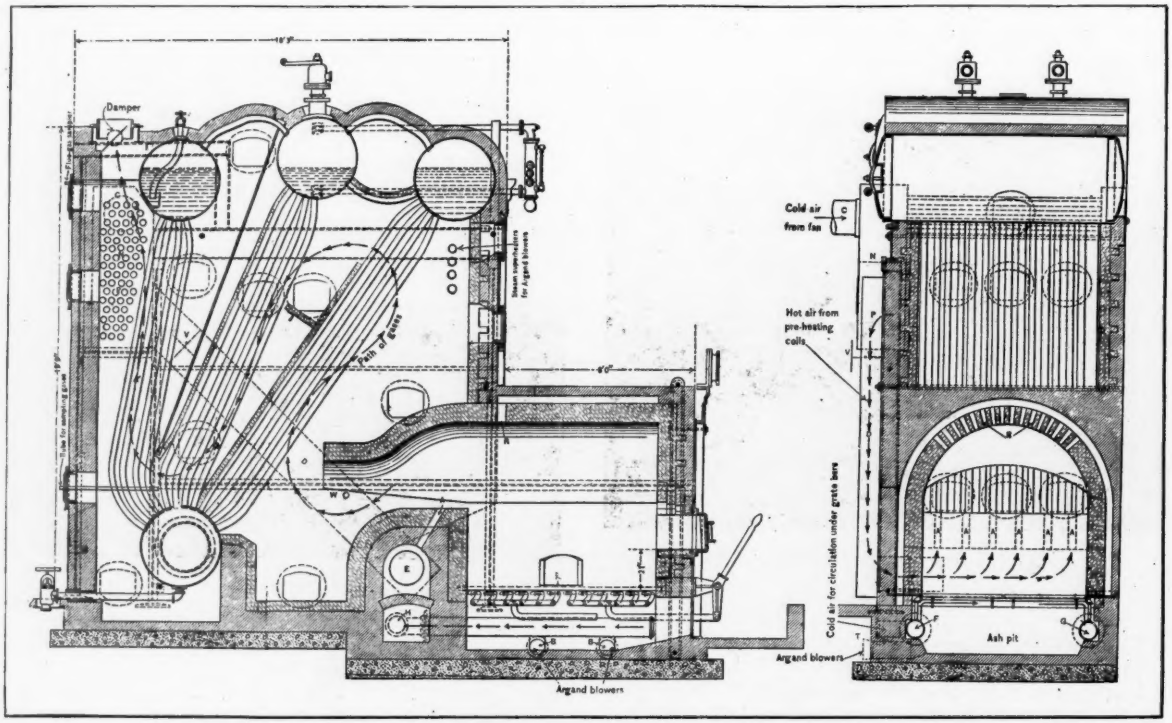

FIG. 3. DETAILS OF SETTING OF BOILER FOR LIGNITE BURNING AT THE U. S. RECLAMATION SERVICE, WILLISTON, N. DAK.

As a fuel for power purposes, the greatest drawback has been in burning it under the common return tubular boiler with setting as most generally used in the soft coal regions. This has been the case in all plants which I have seen, with one notable exception.

Proximate analysis, with location of mine, and thickness of vein, are given herewith. Except as otherwise noted, these figures are taken from bulletins of The U. S. Bureau of Mines.

At the plant of the pumping station for the Williston Project of the United States Reclamation Service, located at Williston, N. D., are 6 250-hp. Stirling boilers, set in furnaces designed especially for burning a lignite, mined on Government land, adjacent to the plant. In a test of one of these boilers, conducted under the direct supervision of Henry Kreisinger, of the United States Bureau of Mines, an equivalent evaporation of 3.79 lb.

*Professor Babcock, North Dakota University

of water from and at 212 deg. per pound of lignite as fired was secured, a result which compares favorably with average coal, all factors considered.

The furnaces under these boilers are of the semi-gas-producer type, and well worth a study by anyone having to do with the burning of lignite.

The Russell Miller Milling Co., which operates a chain of flour mills through North Dakota and Montana, uses lignite in a number of its plants. While no figures are available as to results, they seemed both satisfactory and profitable.

The Minot Electric Light and Power Co., of Minot, N. D., the Williston Mill Co., of Williston and the Jennison Electric Co. of Fairview, Mont., all use lignite for generating power, and not only find it satisfactory, but are strong boosters for its use.

When power plant owners become willing to be convinced of the difference between lignite and bituminous coal, allowing their engineers some latitude in the selecting of boilers, especially grates and fronts, having their furnaces designed with reference to the fuel to be burned, instead of on conventional lines, much higher efficiency will be secured.

My own ideas of a proper setting of the ordinary return tubular boiler would be not less than 40 in. between grates and shell; a large combustion chamber with mixing piers; some standard form of shaking grate; forced draft with automatic control; and a fireman who graded A-1 from the collar up. The results could be safely guaranteed.

The high moisture content of lignite is its greatest handicap; when relieved of this, as in briquets, it compares favorably with anthracite.

To the present time this has not been made commercially practicable, briquets selling for about the same price as hard coal, so that their high cost confines their use to domestic purposes.

The Bureau of Mines, The University of North Dakota and The Northern Briqueting Co. of Minot are all engaged in efforts along the line of cutting down the cost, with good prospects of ultimate success.

The University of North Dakota, under the supervision of Dean Babcock, has erected and has in operation at Hebron, a briqueting and gas plant of full commercial size and capacity, with all the necessary appliances. The briqueting press has a capacity of 2 tons an hour; the gas plant contains a bench of one retort, one condenser, one exhauster, 2 scrubbers, one meter, and a gas holder, all of these appurtenances being of such size and capacity as are found in general commercial use.

When success is secured, as all seem confident that it will be, it is bound to make this a great manufacturing center. To Dean Babcock more than any one individual belongs credit for the advances already made.

The writer feels that discussion of this subject in Practical Engineer by many engineers of experience would be of great value in bringing to the notice of power users a great field of cheap, as well as reliable fuel, of which they do not now seem to be aware.

Modified System for Estimating Radiation*

PRACTICAL WORKING RULES WITH TABLES FOR USING THE COMMON HEAT UNIT METHOD. BY CARLETON F. TWEED

MANY empirical formulas and various rule of thumb methods have been devised for estimating the proper amount of radiation, in square feet, necessary for heating a room. These have not proved to be very rational for they are not flexible. A change in altitude, in boiler pressure, or better in the temperature of the heating medium, or also, as is the case with certain of these rules, a variation in the proportions of the exposed surfaces, will often render a given rule absolutely worthless. A rule that does not meet all conditions is incomplete.

Writers in a few recent articles have commented upon how variable these formulas and rules are and have made comparisons between them. For example, in one article, a comparison of 13 formulas used by central station companies, the author showed by calculations, for a floor of 5 rooms, a variation of the sum from a minimum of 425 sq. ft. to a maximum of 635 sq. ft. Approximately if one should happen to be right, the use of the other would result in a 50 per cent error. Since similar comparisons by other writers have shown the same wide variation between results, a general conclusion may be stated that: no empirical formula or rule can be relied upon unless checked with that discretion which comes from years of practical experience and application.

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There is, however, one common method now in general use which is rational, is universally advocated by all heating authorities, has been checked by practical experience and application, and is complete, for it can be adapted to any and all conditions of heating. This is commonly known as the "Heat Unit Method."

The principal reason why this method is not more widely used and why there exist so many empirical formulas and rules, which are usually but attempts to simplify this method, is because the calculations necessary have been much too elaborate for the practical man.

The writer found this out in practice and then from a few suggestions given by a fellow engineer, worked out the modified system described herein. However, before attempting to explain how this has been done it will be necessary, in order that all may understand, to describe somewhat in detail the original heat unit method as it is most commonly used.

THE HEAT UNIT METHOD

HEAT IS lost from a room in 2 ways, by conduction and radiation through the walls, windows, and other exposed surfaces; and by convection, or heat carried away by the leakage of air outward through the openings of the room, such as cracks, doors, etc., or filtration through the walls.

Fortunately, fairly accurate data are available for determining the first source of loss. This is in direct

proportion to the difference between the indoor and outdoor temperatures. The general data is in the form of factors or coefficients, which are usually quoted as the B.t.u. transmitted per square foot of exposed surface per hour per degree difference in temperature. A convention "K" for this factor is in common use and is given for various materials and forms of construction in the first columns of both Tables I and II, given in the Practical Reference Tables of this issue. These values have been compiled from reference to several of the best authorities and represent a fair average of all of them.

A point that must be understood in estimating radiation by any method whatsoever is that certain factors which enter into the problem cannot be accurately determined. Close approximations, however, are possible. The exactness of these depends mostly upon the good judgment and experience of the designer. Perfecting these personal equations is then part of every designer's responsibilities.

The second source of loss, the heat loss by convection, is probably the most difficult of these uncertain factors to determine. Many experiments have been made in an effort to obtain exact values, but only in specific instances have they proved at all successful. The authorities differ widely in this matter, some advise allowing enough heat for one air change per hour for ordinary living rooms, others think this is not enough and advise 1½ to 2 changes per hour. For first floor stores, etc., where outside doors are opened frequently, they advise 3, 3½ or 4 changes per hour. In the absence of personal data on this factor good averages may be obtained by using the number of air changes followed by the writer in practice.

I have used one air change consistently in estimating for hotels, office buildings, hospitals, residences, etc., that is for all buildings having small rooms set off by partitions. It would be only in the exceptional poorly constructed buildings that any more than this would be required. In very cold climates, where most buildings are fitted up with double windows, it is doubtful if one air change does occur.

For large open floors, as in a department store, one air change will be far too much; ½, or, perhaps, in an open floor of small area, ¾ of one air change would be nearer right.

In vestibules and entrance halls, 2, 3 or 4 changes may be allowed for, as a considerable amount of cold air will be forced in whenever a door is opened. The number of changes to allow for this depends on how frequently the doors may be expected to be opened.

Another somewhat uncertain factor is the extent of the greater radiation losses on the exposed or windward side of the building. In this country, the south side of the building usually gets the most benefit from the sun and is the least exposed to cold winds. For this reason, it is customary to figure all rooms as if they were on this side and then add a certain percentage of this loss when the room is on one of the more severely exposed sides of the building. The writer has always followed the German Government quotations in this matter with good results. These percentages are somewhat larger than the general American practice. They are given in Table III in the Practical Reference Tables.

When a room is more than 12 ft. high, the mean temperature will be somewhat above the temperature at the breathing line. To allow for this add about 1½ deg. for each foot in height above this limit.

When using the heat unit method in practice, the designer first selects the proper outside temperature on which to base his calculations. This is the most important of the uncertain factors and should be selected with the greatest care. The very extreme temperature recorded for a period of years would be uneconomical in first cost as the extra radiation so figured would only be required for a very few hours per year. The best satisfaction and economy will usually be obtained if a steady minimum temperature of 5 or 6 days duration is selected. Most of the modern systems so designed will stand being forced above their capacity for the very low temperatures of 1 or 2 days duration which are common to all localities.

After the proper outside temperature to figure from has been selected, the designer determines the amount of heat lost from the room, and from this the amount of radiation required in square feet. To do this he will first sum up all of the radiation losses, add the amount he intends to allow for leakage, and then the percentage to be allowed for exposure if the location of the room makes this necessary. This total heat loss is then divided by the rate of heat transmitted, per square foot per hour, from the radiator to the room to obtain the size of the radiators. The general formula is:

Sq. ft. rad. = Total B.t.u. loss per hour ÷ [Kr × (Temp. rad. — Temp. room)].

The accuracy of this formula rests with the value Kr (the convention for heat transmission from a radiator or coil to air for one degree difference in temperature per hour per sq. ft. of surface). This varies with the initial temperature and also with the width, height, method of location, and condition of surface of the radiator. Table IV gives average working values for Kr corresponding to various differences in temperatures between the radiator and the room. The third line of figures give the B.t.u. per sq. ft. per hour for the number of degrees difference in temperature.

A common sense consideration of this table will show that the same value of Kr selected for steam heating ought not to be applied to hot water heating, as is advised in many text-books. When the room temperature is to be 70 deg., a steam radiator has a value for Kr of 1.63 B.t.u., while a hot water radiator has a value of 1.45 B.t.u. The error is 12 per cent, which is much too serious to be taken "approximately."

This tendency to approximate many of the factors is a common fault with users of the heat unit method. Oftener than not, it is done without intelligence and is carried so far as to render the method no better than an empirical formula. The modified system, however, is so simple that the fullest results may be obtained in record time without any undue approximations.

The writer would also advise the use of different values of Kr for the different heights and widths of radiators, as according to recent experiments there is as much as a 10 per cent variation between 1 and 2 column, 15 per cent between 2 and 3 column, and as much as 10 per cent variation in different heights; further, pipe coils are about 50 per cent more efficient

than common radiators. Low radiators are more efficient than high ones (if of same depth) and narrow ones more than wide ones (if of same height). Enclosed radiators are also far less efficient than radiators exposed in the rooms. The values given in Table IV are about correct for a 2-column radiator, 32 in. high, exposed in the room.

The personal equation, all important in heating calculations, should never be neglected. Local conditions which often alter the factors somewhat should always receive consideration. Altitudes for instance, have different temperatures corresponding to a given gage pressure. Further, the average temperature of the steam in any system is from 5 to 10 deg. less than the temperature at the boiler pressure. Many of the best designers now in the trade make use of a standard form on which they record the results of their calculations. These are undoubtedly of much value as they serve to facilitate the work of calculations, as a check over the work after it is in place, and as a future guide to the uncertain factors. The special form shown in the Reference Tables is a very essential feature of the new modified system.

The Modified System

As we should now fairly understand the principles of and the method of calculations necessarily followed when using the original heat unit method, we are ready to consider and will much more readily appreciate and understand the way in which this new modified system has been simplified from the original heat unit method without in any way approximating any of the factors. The system is still complete as it can be applied to any and all conditions of heating.

Two tables, I to be used for steam heating, and Table II for hot water heating, have been prepared. These give values for a new "K" factor which has been termed KRs for steam systems and KRw for hot water systems.

This factor is simply the amount of radiating surface in square feet necessary to compensate for the heat lost through one square foot of heat transmission surface per hour or also the amount necessary to heat a certain amount of air from the outdoor temperature to the room temperature. As used here the factors for air range from ½ to 3 cu. ft., according to the number of air changes to be allowed for. Expressed as a formula for heat transmission surface,

$$\text{KRs or KRw} = \frac{K\,(T1 - T2)}{Kr\,(T3 - T1)} \times 1$$

wherein K and Kr are as quoted before, and T1 = mean room temperature, T2 = minimum temperature allowed for outdoors, T3 = mean temperature of the radiator.

As a formula for air

KRs or KRw = H × number of air changes per hour ÷ [Kr × (T3 — T1)]

wherein Kr, T3 and T1 have the same value as before and H = B.t.u. required to heat one cubic foot of air from the outdoor temperature to the room temperature.

Values of K for various kinds of exposed surfaces are given in the first column of either table. Values for Kr should be taken from Table IV. Later a simple method for correcting this to allow for the different widths and heights of the radiators will be explained. Values of H may be taken from Schrams table of the B.t.u. required for heating air, which will be found in many of the reference books and trade catalogs.

Tables I and II have only been calculated for convenience and cannot be applied to all conditions. They have been calculated to suit the more common of the average working temperatures which are found in ordinary practice. These temperatures have been found to be as follows: 220 deg. as the average in a steam system carrying steam at 2 to 5 lb. gage pressure,—sea level,—170 deg. as the average for a hot water radiator on a gravity system and 70 deg., which is the temperature usually maintained within heated rooms in this country. The values of Kr in Table IV corresponding to these temperatures are—for steam at 220 deg., 1.63 B.t.u., and for hot water at 170 deg., 1.45 B.t.u. Using these figures 5 different values have been calculated for KRs and KRw. These correspond to a difference of 60, 70, 80, 90 and 100 deg. between the room and the outdoor temperatures. As it is not common to find ceilings and floors exposed directly outdoors, the values for these have been calculated for a difference in temperature of 30, 40, 50, 60 and 70 deg. It is common practice to assume attics and cellars about 30 deg. higher than the minimum outdoor temperature allowed for. Dirt floors and floors built close to the ground are figured the same as cellars.

The tables give 8 values of KRs and KRw for heating air. These correspond to ½, ¾, 1, 1¼, 1½, 2, 2½, and 3 air changes per hour.

For any other working temperatures than these the values KRs and KRw can very easily be calculated by using the formula. If the temperatures to be figured for are very constant with any one designer it might prove to be equally convenient to calculate similar tables for use at these temperatures. However, it will not require much time to calculate the factors separately with the formula for each job.

A facsimile of the special form is shown in the Reference Tables which, as mentioned before, is a very essential feature of this system. It is most convenient when made up on sheets 8½ by 11 in., which is beginning to be recognized as the latest standard for all printed matter of this type. The complete data for any one room does not require more than a ½-in. space on the paper. The big advantage of this will readily be appreciated by those who have been in the habit of keeping similar records while using the original method. With these old style records and the original method of calculation it was impossible, if the record was to be at all complete, to record more than 5 or 6 rooms on one sheet. Here it is possible to record 10 and 13 room on a single sheet, the heading being necessary on the first sheet for each floor only.

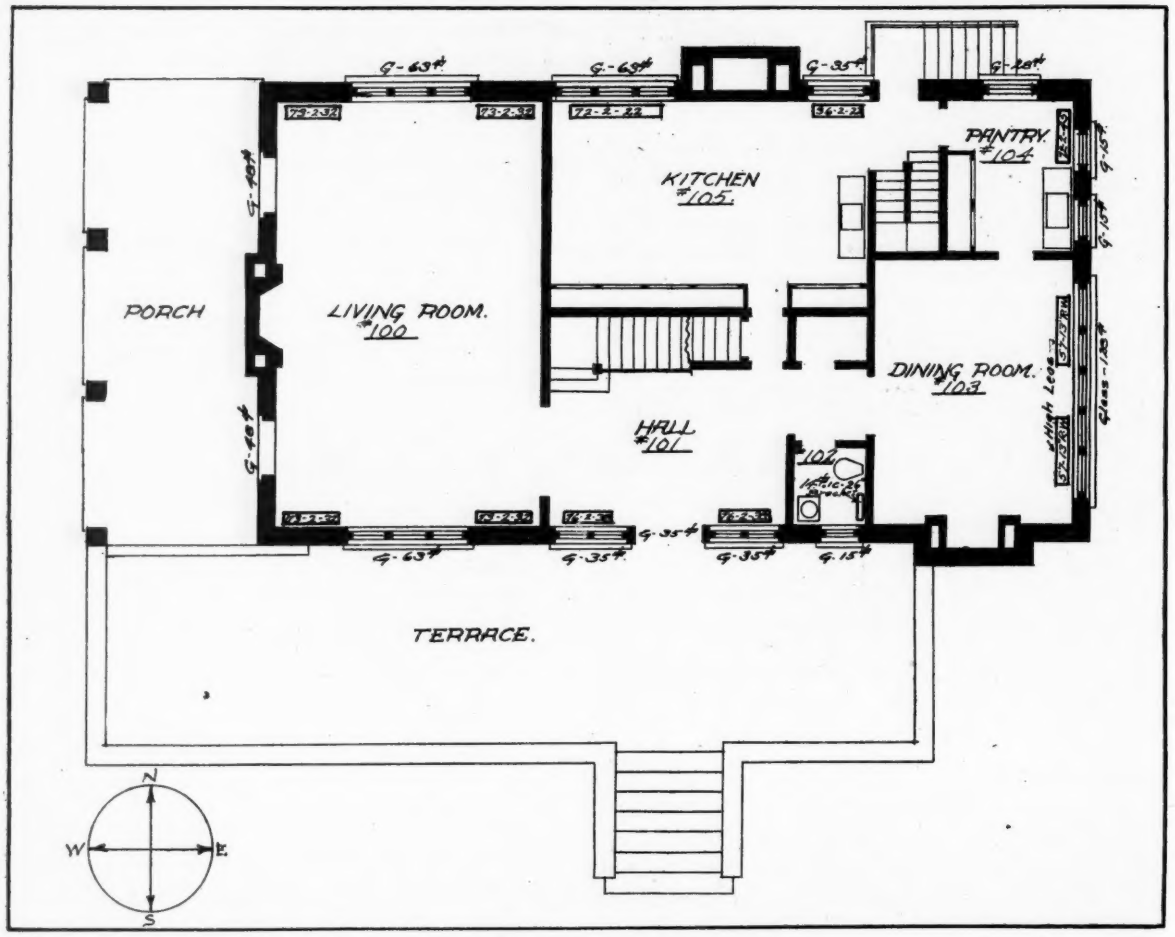
The continuous use of this system and this or a similar type of form will greatly facilitate the work of calculation and save hours of time for the busy engineer or contractor.

When numbering the rooms of a building to correspond to a heating schedule it is well to designate floors. Thus all numbers beginning with 100, as 105, 120, etc., are found on the first floor, while 305, 330, etc., are found on the third floor.

In reading the data from the building plans and recording them on the form, the method of procedure should be about as follows: First, fill out as completely as possible the heating data at the top of the first page. When this has been done, number the rooms in consecutive order, beginning at the lower left-hand corner of each plan and proceeding around the drawing. Inside rooms and closets which will not require a radiator should not be numbered. The next step is to record these numbers with their corresponding room names in the first and second columns of the form. Next record from the drawings, in the third column, the 3 dimensions of each room; in the fifth column on the second small line, the square feet of exposed wall surface; in the sixth column on the third small line, the square feet of exposed glass surface; and in the seventh column on the fourth or bottom line, the square feet of exposed roof or some miscellaneous form of exposure, such as a floor, ceiling, or partition, etc. All data relating to a miscellaneous should be carefully noted in remarks. Further, if, as occasionally happens, a miscellaneous and a roof exposure occur in the same room, the data relating to the former should be noted in remarks and added later to the sum in the column headed radiation sums.

Record also at this time, while taking the other data from the plans, in the column headed exposure, on which side of the building the room is located. For this use the common convention of direction, N. S. E. W., NE. NW. SE. and SW. Later in the same space note the percentage factor for exposure taken from Table III.

Generally the factor KRs or KRw, as the case may be, for any one item will be the same for all the rooms on any one floor. Enter each of these different factors for volume, wall, glass, roof, etc., in the column headed factors and on the same small line as the corresponding data figures, for which it has been calculated. Thus the factor in the example 0.0114 is for volume and has been placed on the first small line opposite to the data figures for volume. Similarly the factor 0.346 is for glass and has been placed on the third small line opposite to the data figures for glass.



FIRST FLOOR PLAN OF RESIDENCE

The designer may now take his slide rule and quickly calculate the volume of each room. This should be noted in the fourth column on the first small line. Now, to obtain the square feet of radiation necessary to compensate for the heat loss chargeable to each of the separate items it is but necessary to multiply the data figures by the factors. Each result should be carried to

one decimal and recorded on the same small lines opposite of the factors in the first half of the column headed radiation sums.

When these have all been noted, their sum for each room should be determined and entered in the last half of this same column. This sum will then be the required amount of radiation for a room of southern exposure, except for the correction necessary for different heights, widths, etc.

For rooms on the more severely exposed sides of the building, multiply this sum by the percentage factor for exposure and note the amount so obtained in the column headed "corrected size," which follows. This will then be the required amount for these rooms, except for the same aforesaid corrections. In the next column note the number of radiators to be placed in each room, and in the column which follows enter the standard size of radiator to be used, as: 2 col.—32 in.

The record will now be complete except for those who wish to make the corrections for the different heights, widths, etc., of the radiators. As this has been made a very simple matter with this system, there should no longer be any excuse for omitting a much needed correction.

As was mentioned before, the values of Kr in Table IV are about correct for a 2-column radiator over 32 in. high. In Table V this value has been taken as being equal to 100 per cent and simple percentage factors calculated for making the correction to any other height, width and class of radiator. The values of Kr quoted for the different types were taken from the results of experiments made by well known authorities and quoted in a table recently published by Geo. Stumpt, Jr.

To make the correction on the form, enter the factor in the same space as the standard size of radiator, multiply the amount as determined above by this factor and enter the final size of the radiator in the last column next to "remarks."

Often it will prove convenient to add up the sums of each of the items. This is especially true for the amount of radiation installed and that equivalent to Kr $\times$ (T3 — T1) B.t.u. per square foot per hour, as this will be the value used in proportioning the boiler and piping to the system.

Aside from possible data on a miscellaneous factor, "Remarks" affords a convenient place for the designer to record any comments he may wish to make on his calculations. It will also prove convenient for such items as complaints of too little or too much heat, etc. If systematically kept, a few of these records should do much towards determining more exact values for the 2 more difficult-to-determine uncertain factors, the heat lost by convection and the proper percentage to allow for increased exposure.

To illustrate further the use of this system, the radiation has been figured for the first floor plan shown here, and each item noted in its proper place in the form given in the Reference Tables.

The house was assumed to be in Minneapolis, Minn., where the minimum temperature to allow for is —30 deg. F. As the room temperature is maintained at 70 deg., the temperature range (T1 — T2) is 100 deg. The system used will be gravity hot water. The basement is heated. For these conditions, the values of KRw should be selected from the 100-deg. column, Table II.

A ¾ air change is allowed in each room except the entrance hall where 2 changes are allowed. The walls are of 12-in. brick, with furring space and plaster. Double windows are used. The heating engineer must be careful of this as the factor for a single window is much greater than for a double one. Also the leakage loss will be less with double windows.

The value of KRw for these exposures are as follows: 0.0114 for a ¾ air change, 0.0304 for 2 air changes, 0.138 for the wall, and 0.346 for the glass. The ceilings and floors are not considered, as the temperature is the same on both sides. One must be careful of these, however, as it is very easy to overlook them. Occasionally a floor overhangs and is exposed outdoors. Sometimes the basements are not heated and many houses have an unheated attic.

The method of correcting the exposure and the corrections for the various widths, heights, etc., is plain in the form, and needs no further explanation.

In order that the piping to the radiators may be proportioned correctly, the amount of radiation carried on each pipe should be summed up after the correction for exposure has been made, and before the corrections have been made for the different heights,, widths, etc., of radiators. That is, the sums should be taken from the column headed "Corrected Size." If this is done, each square foot of radiation at the boiler is equal to 245 B.t.u. for steam and 145 B.t.u. for hot water. After this sum has been estimated, it should be noted properly in the heading.

Tearin' Down the Ol' Plant

By Chas. Fenwick

I HEV spent my best years,"
Said Bill through his tears,
"In that plant thet they're now tearin' down.
I hev made a small pile;
'Spects ter rest fer a while
'Fore I'm called on to wear a gold crown.

"Why it seems like ter me—
But o' course it can't be—
Thet each brick in thet ol' boiler wall
Is laced ter my heart,
Like they hated ter part,
An' I feel all het up when they fall.

"An' the bell ter the mill,
An' the whistle so shrill,
It jes' seems thet they're callin' t' me;
An' I see in my mind,
The ol' days far behind;
Then the tears come an' I cannot see.

"Oh, you young chaps won't know,
Till ye much older grow,
What it means ter see your ol' plants
Bein' ripped all apart;
Seems ter grip on yer heart.
Stop the tears in your eyes? Well, yer can't."

Humphrey Gas Pump for Irrigation Project

OPERATION AND CONSTRUCTION OF PUMP AND AUXILIARIES; HIGH THERMAL EFFICIENCY, LOW INITIAL AND OPERATING COSTS. BY ALEXANDER POTTER AND C. C. TRUMP

IN reporting upon the project to irrigate certain lands in Texas owned by the G. Bedell Moore Estate, along the Rio Grande River extending from Del Rio to within 10 miles of Eagle Pass, the engineers employed had to decide between a gravity system involving the construction of a supply canal some 16 miles long to water approximately 12,000 acres of land, and a pumping project to irrigate at once some 6700 acres and to be extended to meet the needs of the Estate.

Tentative plans and reports showed that the supply canal of the gravity project could be constructed for about $300,000, with an annual expense for fixed charges, maintenance and operation of approximately $40,000 irrespective of the use made of the canal. On the other hand, it was found the pumping project could be built for $60,000 and would entail an annual expense for fixed charges and depreciation, of $6000, and for maintenance and operation, $7700. As the pumping project appeared so much more attractive financially than the gravity projects, its adoption was recommended.

In view of the low cost of installation, fuel consumption and maintenance of the Humphrey gas pump, and as a result of tests made on mesquite fuel in the Akerlund type of gas producer, an Humphrey pump and Akerlund producer were recommended.

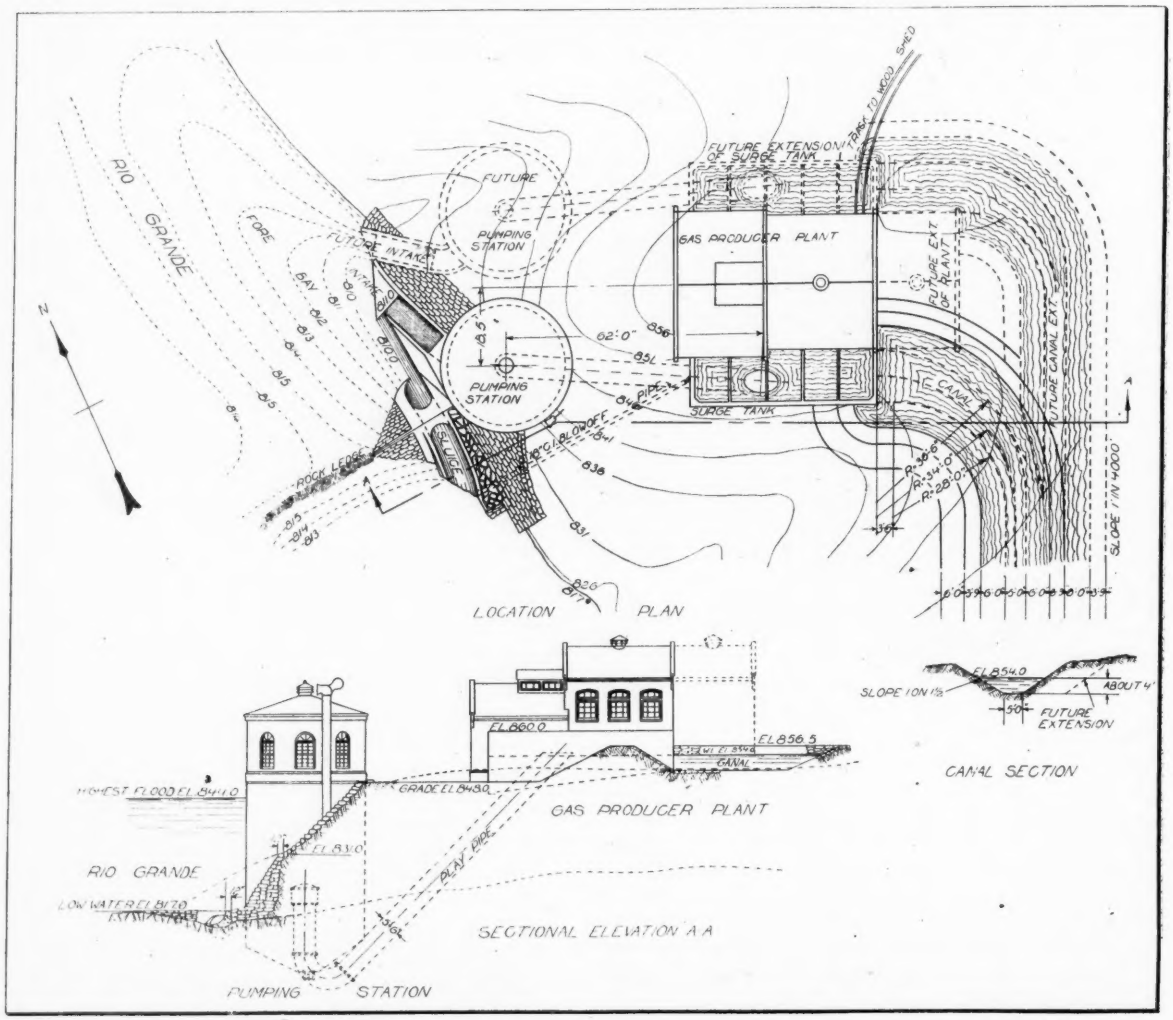


FIG. 1. GENERAL PLAN AND SECTION OF THE G. BEDELL MOORE ESTATE IRRIGATION SYSTEM PUMPING STATION

The pumping engine selected is made under Humphrey and Smyth patents by the Humphrey Gas Pump Co., of Syracuse, N. Y., and is guaranteed to pump not less than 20,000 gal. per min. against a static head of 37 ft., and as it is believed that it will deliver in the neighborhood of 30,000 gal. per min., all structures have been designed accordingly. The thermal efficiency

of this pump is guaranteed by the manufacturer to be not less than 20 per cent of heat energy in the gas turned into work on the water when using producer gas having a heat value of not less than 100 B.t.u. per cu. ft.

In the main conveying the gas from the producer to the pump is placed a holder, and a receiver consisting of a tank 3 ft. 6 in. by 25 ft. and designed to resist an internal pressure of 100 lb. per square inch forms the section of gas main where it passes down the well wall.

Operation of Pump

Operation of the Humphrey gas pump is similar to the 4-stroke Otto cycle with the exception that in this pump there is complete expansion, whereas in the Otto cycle the losses from exhaust taking place under a high back pressure are considerable.

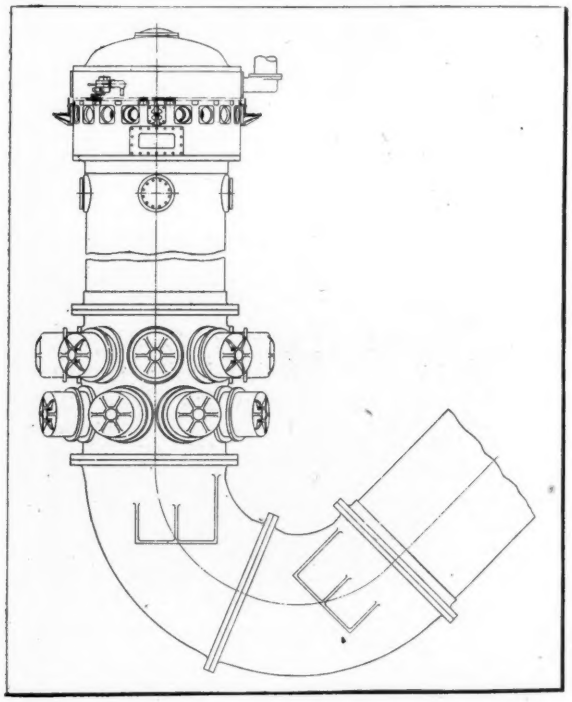


FIG. 2. ASSEMBLY OF 66-IN. HUMPHREY PUMP

To start the pump, the proper mixture of air and gas is forced into the cylinder by a small gas-engine-driven air compressor of the 2-cylinder type, one cylinder pumping air and the other gas. Two separate systems of ignition are furnished, one consisting of special spark plugs operated from storage batteries and the other from an electric generator.

After the proper mixture of air and gas is in the cylinder, all the valves being closed, the charge is exploded by an electric spark, directly over the surface of the water, no piston or moving parts being used, and the increase in pressure resulting therefrom drives the water in the pump head downwards, setting the whole column of water in the play pipe in motion. This column of water acquires kinetic energy during the period when work is being done upon it by the expanding gases. By the time these gases have expanded to atmospheric pressure, the water in the play pipe is moving at a high velocity, and as the motion of this column of water cannot be suddenly arrested, the pressure in the explosion chamber falls below atmospheric, when both scavenging and water valves open. A certain amount of water enters through the suction valves, most of which follows the moving column in the play pipe, while the rest rises in the explosion chamber. To assist the scavenging action, a certain amount of air is admitted to the explosion chamber to mix with the spent gases.

Most of the kinetic energy in the moving column is expended in forcing water into the surge tank, and, as soon as the column of water in the play pipe comes to rest, it starts to move back towards the pump, gaining velocity until the water reaches the level of the exhaust valves, which are shut by impact. A certain quantity of the burned products mixed with the scavenging air is now imprisoned in the cushion space and the kinetic energy of the moving column is expended in compressing this to a much greater pressure than that due to the static pumping head.

As a result of the energy stored in these entrapped gases, the column of water is again forced outward; the

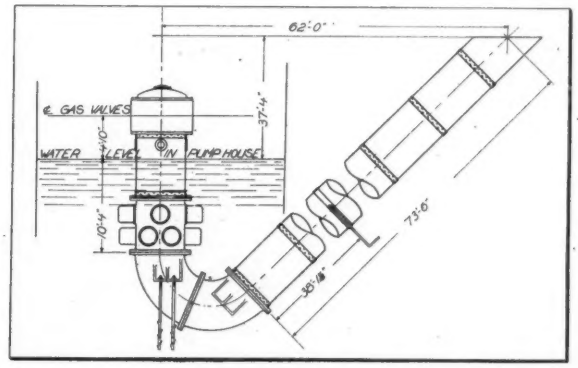


FIG. 3. 66-IN. HUMPHREY GAS PUMP

pressure in the gas head is again reduced below atmospheric pressure, when a fresh charge of gas and air is drawn into the explosion chamber. Again the column of water returns and compresses the charge of gas and air which is then ignited to start a fresh cycle of operation.

Primarily, the period of cycle of the pump is determined by the length of the reciprocating column of water in the play pipe. This motion is similar to the swing of the pendulum of a clock, and its period of vibration is governed by the length of the water column in the same way as is the period of swing of a pendulum by its length. As a general rule, assuming the column to be of uniform section, the period of vibration is almost proportional to the square root of the length of the water column. The Del Rio pump will average about 12 complete cycles per minute.

Construction of Pump

As shown in Figs. 2 and 3, the combination of explosion cylinder, valves and play pipe which forms the pump takes the shape of a short legged V, the play pipe extending up the bank of the Rio Grande at an angle of 45 deg. from a 2-part, 135-deg. bend upon which

the water valves and power cylinders are set. The upper end of the play pipe is held in a reinforced concrete surge tank, while the lower end and bend is imbedded in the bottom of the concrete pump well.

The major parts of the unit are of steel; the straight parts of play pipe and cylinder are of plate with welded or riveted joints, while the more intricate parts, such as cylinder head, belt for gas valves, box for water intake valves, and the 2 bends are unusually large steel castings. Working parts subject to corrosion from actual contact with water; such as valves and seats, are made from manganese bronze.

Having a total length in its straight part of 73½ ft., the delivery is made in 3 parts for convenience of transportation and economical distribution of metal. The 2 rings farthest from the power cylinder, where the pressures are low, are made of 5/16-in. plate, having a tensile strength of 60,000 lb. per sq. in., while the other 8 rings are each thicker than the one before by 1/16 in., until the one nearest the bend has a thickness of ⅞ in. All seams are riveted butt joints with outside straps and heads countersunk inside the pipe.

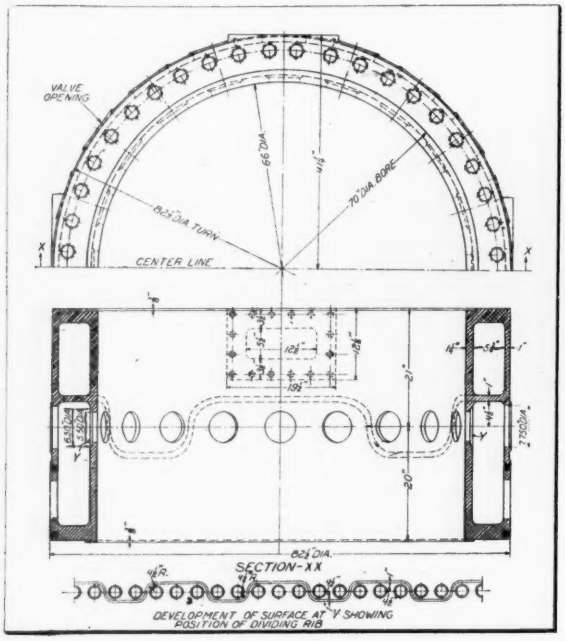


FIG. 4. SECTIONAL VIEW OF GAS BELT

Between the play pipe and cylinder is a 135-deg. bend made of 2 steel castings bolted together, for convenience in handling and transportation. The 2 67.5-deg. parts are identical, except that the tenons are reversed.

Water Valves

Immediately on top of the bend is set the box for water intake valves with its "hat" unit construction. This box, illustrated in Fig. 6, is a steel casting weighing nearly 13,000 lb., having openings for 16 "hats" or cages, each containing 25 valves, or a total of 400 for the pump. The valve cages are semisteel casting into which the valve seats of manganese bronze are forced with a taper fit of 1 in. to the foot.

Water valves are of standard type, according to the Freeman specifications of the Associated Factory Mutual Fire Insurance Companies, but differ from the Standard Underwriter valves in that the largest standard valve is 4 in. diameter, while these are 5 in., a larger valve being permissible in view of the slower speed and more gradual closing of the water valves. Because of the sand in the river water, the valve discs on this pump are of a composition which has given satisfaction in water works service under similar conditions.

Just above the water valve box, and forming part of the combustion chamber, is placed the power cylinder, a piece of riveted pipe, 66 in. inside diameter and 89 in. long.

Supply and Exhaust Valves

Figures 4 and 5 show the belt for gas valves, which carries the important working parts of the pumping engine. This is a steel casting weighing about 9500 lb., and forms a double-walled section of the 66-in. cylinder, through which openings are provided for 8 gas and air mixture and 20 exhaust valves. In order to have an even distribution of flow of gases into and out of the cylinder, these openings are arranged in groups of 2 for mixture and 3 for exhaust, separated by a dividing wall shown in Fig. 4, which runs over exhaust valves

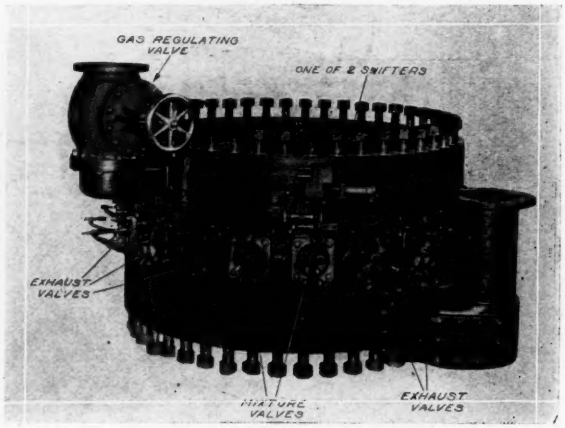


FIG. 5. 66-IN. BELT FOR GAS VALVES WITH VALVES ASSEMBLED

and under mixture valves, around the annular space between the outer and inner walls of the belt itself. Thus the belt is divided into an upper chamber provided with a rectangular opening, to which the gas pipe is connected, and a lower chamber with 2 larger similar openings faced and studded for attaching 2 nonreturn valves and the exhaust pipes. The exhaust gases are led downward to allow any water carried with them to drain off.

Each mixture valve cage, Fig. 8, is assembled as a unit. It comprises a double, flat-faced bronze valve of the mushroom type with a 1-in. tubular stem expanded into the valve head casting and fastened with a driven taper plug. The outer end of the valve stem is threaded inside for a locking nut or head, which is fastened by an expanding bolt acting inside the quartered, threaded projection. The seat on which the valve works is also

double faced, 2 concentric openings of equivalent area being provided. The inner one is for air drawn from the atmosphere directly through the cage around the valve stem, while the outer one takes gas directly from the upper chamber of the belt, an arrangement keeping tar or other impurities which may be carried in the gas, as far as possible from the moving stem.

The exhaust valve cage unit is interchangeable with that for mixture and differs from it in but few details. The valve is of the same mushroom shape as the mixture valve, but has only one flat face at its outer circumference. It is opened by the outside spring and much depends upon doing this promptly at the end of expansion to secure a full volume of scavenging air by the subsequent suction. This air is drawn in directly through the exhaust valve cage. A spring-closed scavenging valve which has its seat against the inside of the exhaust cage cover prevents the products of combustion from escaping into the air, and the nonreturn valves between the belt and exhaust line keep exhausted gases from returning into the cylinder instead of the fresh air.

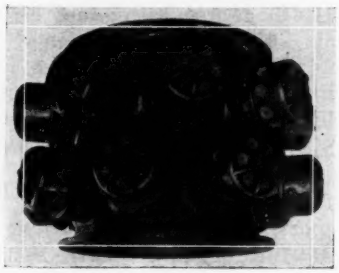


FIG. 6. 66-IN. BOX FOR WATER INLET VALVES WITH CAGES

The exhaust seat is a bronze casting similar to that for the mixture valve, but without the concentric walls for dividing gas and air passages. A full length stem guide is used as a rider for the scavenge valve, the spring of which is held in place by 4 ribs, as shown in Fig. 7.

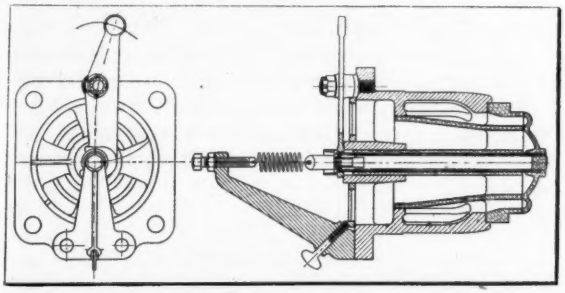


FIG. 8. ASSEMBLY, 5-IN. MIXTURE VALVE

VALVE INTERLOCKING

UPON THE interlocking mechanism depends the entire possibility of the 4-stroke cycle. From the foregoing description of operation of the pump it is evident that it is necessary to lock the mixture valves and unlock the exhaust valves during the expansion following the power stroke, and to lock the exhaust valves and unlock the mixture valves during the charging stroke. This is accomplished by a sprocket roller chain stretched around the belt above the gas valves and carrying lugs which engage the locking levers of the exhaust valves in one direction, and those of the mixture valves in the other direction. With each explosion the chain and lugs are moved against the upper ends of the exhaust valve lock levers, but the valves do not open until the pressure is below atmospheric. On the following "cushion" the chain is moved in the opposite direction, which disengages the exhaust valve levers and allows the valves to be locked by gravity, and engages the mixture valve lock levers, moving them to unlock position from the gravity lock previously assumed.

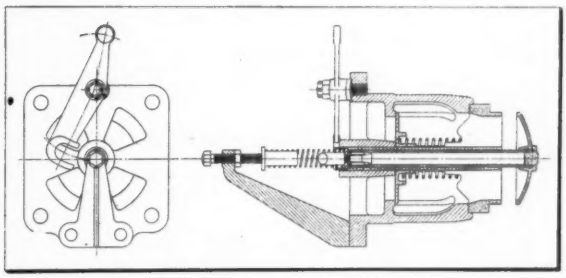


FIG. 7. ASSEMBLY, 5-IN. EXHAUST VALVE

The chain is moved by 2 small hydraulic engines called "shifters," shown in Fig. 9, each consisting of a spring-loaded horizontal piston in a single-acting cylinder, 2½ in. diameter, connected with the play pipe pressures. A spring placed between piston rod spearhead and chain-control lever causes the spearhead to engage upper and lower studs on the chain lever, securing the reverse motions desired. The shifters also serve to actuate the timers, or contact makers, for the electrical ignition system.

SURGE TANK

DISCHAGE FROM the play pipe is into a surge tank, 36 ft. long by 12 ft. wide, and is constructed entirely of reinforced concrete, as shown in Fig. 1, the discharge pipe extending 9 in. above the normal water level in the canal. The guaranteed lift of the pump is fixed at 37 ft., but this is insufficient to supply a tract of 500 acres in the immediate vicinity of the pumping station. It is intended to take advantage of the wave action in the surge tank and thereby raise a small quantity of water 4 or 5 ft. above the elevation of the water in the supply canal. This tank is also designed to act as a grit chamber, the grit to be washed into the river through an 18-in. cast-iron pipe.

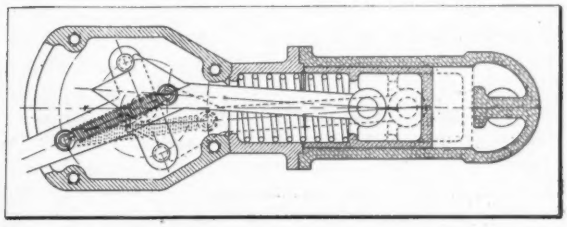


FIG. 9. SECTION OF SHIFTER MECHANISM

Thermal Efficiency

For this pump the thermal efficiency is guaranteed to be not less than 20 per cent, a conservative figure, in view of the fact that official tests made on 5 Humphrey pumps show that the large pumps tested possessed a thermal efficiency ranging from 22.19 to 24.07 per cent, while a smaller unit showed up an average thermal efficiency of 26.36 per cent. The following table is a summary of the results of 30 official tests:

Summary of Results of Pump Tests

Pump No.	1	2	3	4	5
No. of Tests	6	6	6	6	6
Average duration of tests, min.	9.27	8.95	8.37	9.67	10.0
Lift in feet	30.01	30.24	30.06	32.6	30.24
Water pumped, gal. per min.	40,088	39,327	39,656	39,196	21,739
Water hp. developed	303.9	300.4	301.1	322.7	166.0
Gas used per min. at 60 deg. F. and 30 in. mercury, cu. ft.	395.4	393.3	391.5	400.1	191.6
Calorific (lower) value of gas, B.t.u. Cu. ft.	145.7	146.4	146.2	142.2	138.1
Average Thermal efficiency, per cent	22.39	22.19	22.33	24.07	26.63
Anthracite used per water hp.-hr., lb.	0.946	0.957	0.949	0.881	0.796

Gas Producer Plant

This will be located adjacent to the surge tank, as may be seen in Fig. 1. The producer system to be used is that of the Standard Gas Power Co., of New York City, and comprises a vertical down-draft generator with water pan on top and vapor ring around the combustion belt; air is admitted to the vapor ring and the mixture of air and steam enters the fuel chamber above the green charge. Gas is let in in succession through a spray-cooler, wet-scrubber, exhauster, dry purifier and a delivery pipe.

When using moderately dry mesquite wood, the producer will have a capacity of 5,000,000 B.t.u. per hr. generated in the form of gas. The minimum heat value of the gas per cubic foot is guaranteed at 100 B.t.u., the quality not to vary more than 10 per cent from the average. These quantities are based on results obtained from a test made by the manufacturers at their Jersey City plant with a similar type of producer.

We all want efficiency, and read eagerly all that is written on the subject. Yet we find little that is of practical value except this: We are spurred to greater activity—greater care in our work upon reading such material. If my name were John Jones I believe I would start the John Jones system of Personal Efficiency (and if it were Joe Johnson I would start the Joe Johnson system). It would be simply this: I would say to John: "John, the thing you want most in the world is this (and knowing John better than anyone else, I could tell him just what it was). Now, John, in order to get this you'll have to do better—think clearer—work harder. Do you understand?" And John would understand—and act!

Rust-Proofing Iron and Steel

In the Chemical Engineer, a number of processes are outlined for doing this work, some of them by the heat treatment process, and others by dipping. The 2 which are given as most satisfactory, are as follows: For heat treatment, the process devised by John J. Bradley in 1908, consists of heating the articles to a red heat at about 900 deg. F., in a muffle, and introducing hydrogen gas, and also gasoline in small quantities, in order to improve the color of the coating. The muffle is of the ordinary type, using coke as a fuel, and the articles should be thoroughly cleaned before treatment, by tumbling, pickling or sand blasting, the last mentioned being preferred. The articles are left in the furnace for an hour or more, then taken out and allowed to cool, and finally oiled with linseed or paraffin oil.

As a dipping method, that known as Coslettizing, invented by Thomas W. Coslett, is found satisfactory, and is as follows: The solution is made up of concentrated phosphoric acid, 1 qt.; water, 1 qt.; iron filings, 1 lb. This is allowed to stand until the iron is thoroughly dissolved, and then the solution is added to water, in proportions of 1 part solution to 50 of water. The work to be treated is first cleaned, as if for plating, either by scratch brushing, or by immersion in a muriatic acid dip, to remove any rust that may be present. The parts are suspended in the solution by means of iron wire or hooks, or in the case of small articles, by placing in iron or earthenware baskets. The solution must be kept close to the boiling point, and the articles are allowed to remain in it for from ½ to 3 hr., depending upon the nature of the work, a heavy coating being produced in 2 to 3 hr. time. A convenient arrangement for the bath is to make up the solution in an enamel or agateware tank, and heat this by placing it in boiling water. After the articles are removed from the solution, they should be allowed to dry in air, and may then be scratch brushed on a fine wire wheel, revolving at 600 r.p.m., and oiled with linseed or paraffin oil.

Another solution devised by Mr. Coslett is composed of 6 oz. of zinc, 1 pt. of phosphoric acid and 1 pt. of water, making a stocked solution which is diluted in the proportions of 1 oz. stock solution to a gallon of water. The method of performing the working is the same as for the other solution.

U. S. Civil Service Commission announces an examination, March 2, 1915, for designing engineer, to fill a vacancy in the Reclamation Service, Washington, D. C., at a salary ranging from $2000 to $3000 a year. The following subjects will have the relative weights indicated: General and technical education, 20; general engineering experience, 30; special engineering experience, 50. Applicants must furnish evidence as follows: That they have had not less than 5 yr. of irrigation engineering experience; that of these, not less than 2 yr. were spent in the preparation of original designs of irrigation structures, or in the examination or review of similar submitted designs; that they have had experience in the supervision of the execution of such design. Apply for Form 1312, giving the title, Designing Engineer (Male).

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Practical Electrical Tests

INSTRUMENTS USED IN TESTING; METHODS EMPLOYED. BY ELMER F. CRESSY

THE operating engineer, particularly if he is employed in an office or apartment building, or in an industrial plant, quite frequently must trace out troubles in the power, lighting and signal circuits in the premises under his jurisdiction. If attached in a systematic manner, they can, with the aid of suitable devices which the engineer can for the most part make for himself from materials that are always available, be quickly solved. It is the intention to describe in these notes a few practical devices and methods that have been used with considerable success in locating the ordinary troubles with which the operating engineer must contend.

Every man that must maintain electrical equipment will sooner or later construct a test lamp outfit. Frequently the ordinary weatherproof socket with the ends of its 2 flexible conductors bared is made to serve the purpose. This makeshift is satisfactory for emergency work, but as a general proposition it will pay to assemble a test plug and socket like that suggested in Fig. 1. One end of the cord of the outfit is made up into an extension plug, which should preferably be of the type that can be screwed into a socket without twisting the cord. The socket of the outfit can be of the keyless type, and should have a wooden handle and a lamp guard on it. A wire hook fastened into the handle is a convenient addition, because it provides for hanging the lamp on some convenient object when the test is being made. A low wattage lamp can be screwed into the socket, because the only illumination necessary when making the test is enough to indicate whether or not current is flowing through the lamp. Some men prefer a 250-v. test lamp to a 110-v. lamp, because the former can be used on a 110-220-v., 3-wire circuit, without any danger of its being burnt out. Even if the lamp is used only on 110-v. circuits, one of a voltage of 250 will have much longer life than a 110-v. lamp.

The flexible cord which connects the lamp socket to the extension plug should be 10 or 12 ft. long. A couple of feet back from the socket one of the strands of the cord is cut, and a 3-ft. length of single strand cord is soldered to each strand, as shown in the illustration. At the outer end of each of these single strands a pointed piece of No. 6 wire is soldered.

In using the test plug, its extension plug is screwed into a convenient lamp socket and the copper wire styluses are pressed against the 2 metallic portions of the circuit that is being investigated. In testing for a short circuit they will be pressed directly against the terminals of the device under inspection. If the lamp glows, it is evident that there is a short circuit in the device. In testing for a ground, one of the stylus points is pressed against the conductor of the device, and the other point pressed against some grounded metallic object. A glowing of the lamp will indicate a low resistance ground, and probably any ground heavy enough to cause material trouble in operation will allow enough current to flow through the lamp at least to redden the filament. A high-resistance ground cannot always be indicated by this method. If there is a suspicion that a high-resistance ground exists, some tests made with a magneto will usually localize it.

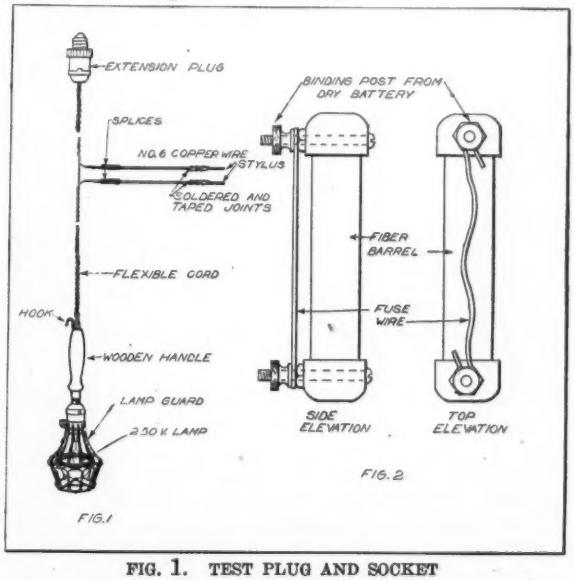


FIG. 1. TEST PLUG AND SOCKET
FIG. 2. CONVENIENT FUSE FOR TESTING

At the places where the copper wire styluses are soldered to the flexible cord, a heavy serving of tape should be applied, which will provide insulating handles at the points.

Another simple device that has been found useful and economical in tracing trouble on motor circuits, is shown in Fig. 2. When searching for motor troubles, it many times happens that a number of fuses are burnt out before the trouble is found. Where National Electrical Standard Code fuses are used, this burning up of fuses is rather an expensive proceeding. This expense can be avoided to a great extent by rigging up a fuse outfit like that shown in Fig. 2, consisting of a fuse

casing, from a burnt-out fuse, to which a short length of ordinary fuse can be mechanically and electrically connected with a couple of binding posts. The fuse case, which may be of either the ferrule or knife blade type (the ferrule type is shown in the illustration), should, of course, have its metallic end caps intact. Where a fuse casing of small capacity is used, the binding posts can be arranged (see illustration) from the binding posts of an old dry battery. For larger casings, dry battery binding post thumb screws and nuts can be utilized, but it will be necessary to obtain a longer screw than that used in the dry battery for attaching the nuts to the casing.

When a motor because of some trouble blows its fuses, the trouble man can, before he commences his test, insert the testing fuses (Fig. 2) in the cut-outs protecting the motor. Then when he starts the motor in

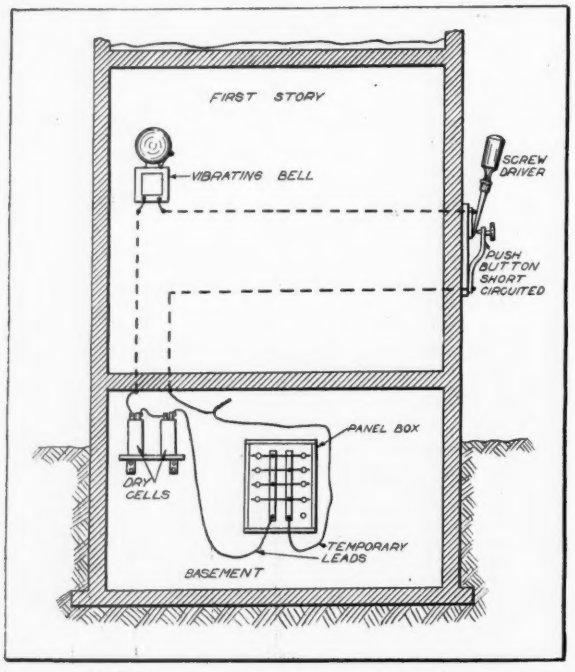


FIG. 3. TESTING ELECTRIC LIGHT WIRING

an effort to localize the difficulty, cheap pieces of fuse wire will be destroyed, rather than expensive enclosed fuses, if there is a short circuit in the motor, or if it is overloaded.

A convenient method of testing out electric-lighting circuits, either in new or in old installations, is suggested in Fig. 3. This can be applied only where there is an electric bell circuit in operation in the building where the circuits are to be tested. At some convenient point the electric-bell wiring is opened, and the 2 bus bars of the electric lighting panel box or of the cutout blocks are connected in series with the bell circuit (Fig. 3). The push button is short-circuited either by twisting the wires to it together, or by placing a screw driver between its contacts. With the connections as shown at Fig. 3, a short circuit on any branch lighting circuit will cause the electric bell to ring. When it does ring it can usually be heard, even if the panel box or cutouts are in a remote location in the building. By opening the panel box switches, one at a time, or by removing the fuse plugs from the cutouts, the trouble can be immediately localized to some one branch circuit. Then by disconnecting the fixtures on the branch circuit, one at a time, the short circuit can usually be found. Short circuits on electric lighting branches are nearly always found in the fixtures and seldom in the concealed wiring.

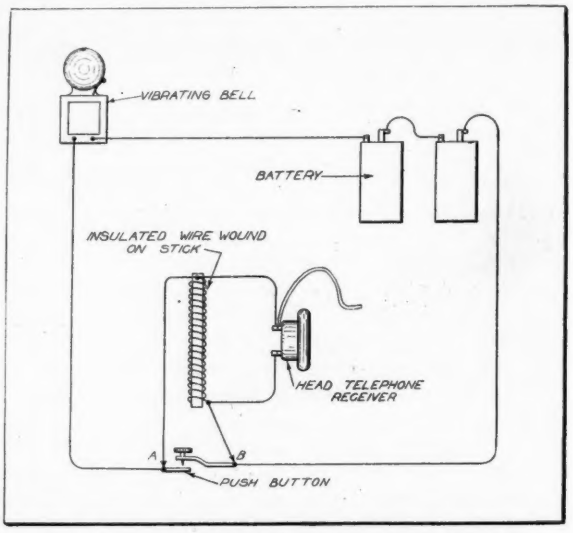


FIG. 4. TESTING A SIGNAL CIRCUIT WHEN BELL IS INACCESSIBLE

If the bell still rings when all of the branch circuits are disconnected, the trouble must be in the concealed wiring and then the method of tracing the trouble suggested in connection with Figs. 7 and 8 can be used.

A great many wiremen that do a large amount of work in finished buildings make all of their final tests of the wiring before leaving the premises by the method outlined in Fig. 3. This procedure saves them the

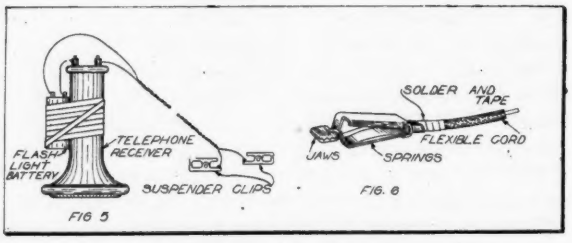


FIG. 5. A SELF-CONTAINED TESTING OUTFIT
FIG. 6. CLIP FOR TESTING

trouble of carrying around an electric-bell-test outfit. It occasionally happens when it is necessary to find trouble on an electric-bell circuit in a building, that access cannot be obtained to the bell and batteries. It may be that the bell and batteries are in a room that is locked, or it may be that the building containing the circuit is located so that the only component of the system that is available is the push button. In such a case, a test that will indicate in a general way where the trouble lies, can be made as shown in Fig. 4.

About 12 ft. of No. 18 cotton insulated annunciator wire is wound on a stick to form a coil of low resistance. Then the terminals of a telephone receiver are connected

across the coil. With the telephone receiver in position on the tester's head, he touches the terminals from the coil, A and B, Fig. 4, across the terminals of the push button. If the bell is in working order and therefore rings, a vibrating noise, somewhat similar to that of the vibrating bell, will be heard in the telephone receiver. If the test indicates that the bell is not ringing, then it is possible to ascertain in the following manner whether the bell is in circuit. Wire A is held continuously against one terminal, and wire B is touched intermittently against the other terminal. If a click is heard in the receiver at each tap, it indicates that the bell is connected in the circuit, and that current is flowing through it, but that it is not breaking its contact properly and hence needs adjusting. If no click is heard in the receiver as B is tapped against the push button terminal, the bell circuit is open. It may be that the bell is disconnected, that a battery wire is open, that all of the solution has evaporated from the cells, or that the wiring of the circuit has been severed.

A telephone receiver affords a delicate and convenient testing instrument for signal circuit work, but the many ways in which it can be used do not appear to be generally appreciated. It is desirable to have a receiver test outfit that can be carried in one's pocket. Such an outfit is shown in Fig. 5.

It comprises an ordinary telephone receiver to which one cell of a flash light battery has been secured with friction tape. A short piece of annunciator wire is connected between one receiver terminal and one battery terminal. To the other receiver and battery terminals are connected the 2 conductors of a length of flexible cord. On the other end of the cord, testing clips (that is, metal clips which when engaged on a terminal will remain there until released, because of the pressure of a spring) are soldered. The clips with which suspenders are often provided can be used for test clips, but where much testing is to be done, it will be found profitable to use the type of clip shown in Fig. 6. This is of substantial construction, and is provided with an auxiliary spring which will firmly hold the device on a terminal. Suspender clips are of such light construction and the distance between their jaws is so small, that difficulty is experienced in engaging them on a terminal, and in keeping them there after they are on. It is extremely disconcerting to have one of these suspender clips pull off a terminal while a test is being made. The clip of Fig. 6 is made of steel and nickel plated. It has a thin nose that can be inserted into orifices. Its teeth in the front and side jaws enable it to grip fine wires or one very small wire. For these reasons it has been found exceptionally handy for laboratory as well as for field work.

In testing with receiver and battery for a ground, one clip is connected to a grounded object, and the other attached to the circuit under test. The intensity of the click heard in the receiver will indicate in a general way the resistance of the ground. Short circuits can be tested out similarly. An arrangement that can readily be rigged up for testing out short circuit in concealed wiring that is not in conduit is shown in Figs. 7 and 8. Figure 7 shows the outfit in use and Fig. 8 illustrates the theory upon which it operates. A spark coil, a telephone receiver, and a group of test lamps mounted on a board, comprise the necessary apparatus. Referring to Fig. 8: If a telephone receiver is connected across the terminals of a spark coil, and the coil is held near a conductor that is conveying a varying current of electricity, the lines of force generated by the conductor will cut the turns of wire in the spark coil. An electromotive force will thereby be induced in the spark coil which will force a current through the telephone receiver.

A spark coil, 10 in. long, containing about 6 layers of No. 14 copper wire, wound on a core 3/16 in. in diameter, composed of annealed iron wires, No. 16 gage, will give good results. A larger or a smaller coil will do if one is available. In testing for a short circuit with the spark coil-telephone receiver (Fig. 7) the first consideration is to get a flow of current through the short circuit. It is obvious that the short circuit, A, Fig. 7, cannot be connected directly across the 110-v. main, because if it were, fuses would be blown. The flow of current through the branch circuit, and the short circuit A is limited in this way: One of the fuse plugs of the

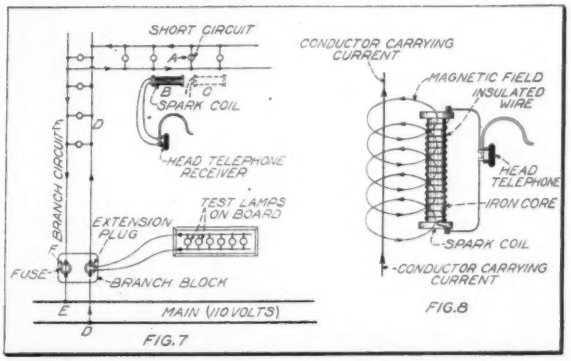


FIG. 7. TESTING OUT A SHORT CIRCUIT; INDUCTION METHOD
FIG. 8. PRINCIPLE OF INDUCTION TESTING

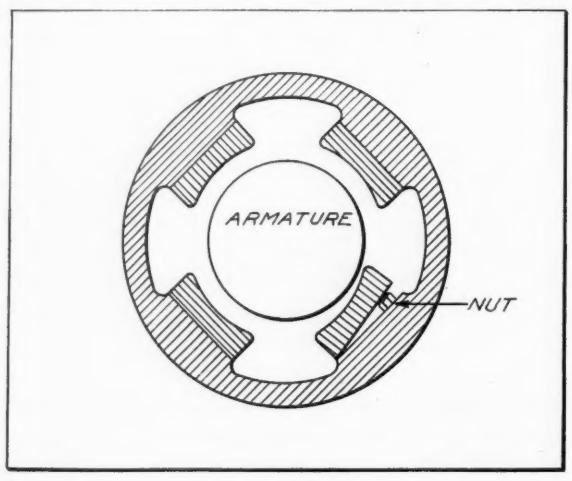
branch block is removed, and in its place is inserted a dummy fuse plug having conductors soldered to its terminals, which connect with a group of lamps in multiple. Six 40-w. lamps mounted in sockets screwed to the test board will usually provide sufficient current. The other fuse in the branch block is left in place. It may be necessary, if the fuses that were originally in the branch block were of small capacity, to substitute one new fuse heavy enough to carry the current that the lamps in the multiple connected group will pass. It is evident that a current now flows from the mains, up conductor D of the branch, through the short circuit, A, and back to the main through conductor E. Now, if the spark coil with the receiver attached, be carried along in the direction of the route of the circuit, and as close to the circuit as possible, a humming will be heard on alternating-current circuits, until the point indicated at B is reached. When the coil is shifted to C, the humming in the telephone receiver will decrease materially or will cease altogether. It will then be evident to the operator that the short circuit is in the neighborhood of circuit A.

On direct-current circuits, as the spark coil is moved along the route of the branch, no humming can normally be detected, but a noise can be produced by making and breaking the current through the branch by screwing in and out the fuse plug F, or in any other convenient manner.

Direct-Current Motor Trouble

READINESS with which trouble may be located in a piece of apparatus often depends upon its accessibility. Where careful inspection is made difficult by reason of the location of a device, it is quite certain that no thorough inspection is ever made.

The following will describe a case in which a large direct-current motor was installed near the ceiling in the darkest corner of a forge room. At times it was with difficulty that even the outline of the motor could be seen from the floor. Only one end of the motor was accessible for air-gap inspection, and even then that end was partly obscured by end shield brackets; these conditions made air-gap sighting or gaging difficult, and it would be a conscientious man with patience and determination who would complete a thorough examination of the condition of the air-gap. Before serious trouble developed the motor had blown fuses at intervals, the frequency of which increased until production was hampered. The air-gap clearance had been tested, but



CAUSE OF TROUBLE

the man who did the testing was not competent, as is evidenced by the fact that the armature lost a band wire a few days afterward. Without careful investigation as to whether or not excessive bearing wear was responsible for the trouble, the bearings were believed to be at fault and a new set was installed. The motor then operated for about a week, after which it began to blow fuses again and then lost another band wire, but not in the same place as the first.

The operator then called in an inspector who determined that the second band wire gave way because it had been injured at the time the first one was rubbed off, and further found that the cause of the initial and subsequent trouble was a thin brass jam-nut which had been trapped between one of the poles and its frame seat. This had entered at the time of reassembling the machine after an overhauling sometime previously. It had allowed just enough clearance to permit installing the armature, but a very little bearing wear had in each case brought the armature band wire and pole-piece hornfiber into rubbing contact. By its braking action, this had first caused the fuse blowing and then the weakening of the band wire, until it broke. It speaks well for the motor that the distorted field incident to the displaced pole-piece did not cause sparking at the commutator.—General Electric Review.

Unsteady Voltage

BY RECEIVER

A 1500-KW. generator in a railway power house was found to be delivering an unsteady voltage, and while the speed of the engine was surging, so was the receiver pressure, which caused the relief valve on the receiver to blow. The engine was stopped and the drip on the receiver looked at to see if the bypass valve was leaking, but was found to be tight. The high-pressure piston was put on the dead center and the steam valves closed and throttle opened, showing practically no leakage.

The valves were double-ported and had short travels. The dashpot was looked over when the gear was moved with the bar and nothing appeared unusual, so the engine was started. The voltage was still unsteady and examination showed that, at times, the dashpot did not drop to its lowest position. Examination showed that the head and about 0.125 in. of one of the copper rivets that held the leather flat that acted as a check valve on the plunger had broken off and fallen between the plunger and its seat. The current of air passing between these 2, moving the head, so at times it did not interfere while at other times it did. Removing it and putting in a new rivet cured the trouble.

THE GOODYEAR TIRE & RUBBER CO. has been advocating for a long time what they call "The Science of Tire Care," believing that, whether applied to a solitary car or to a fleet of delivery trucks, scientific care as opposed to haphazard inspections will pay big returns in reduced tire bills. Now comes another concrete example of the truth of this belief. From a large Middle Western concern comes the information that in a single year they saved well over $10,000 by applying to the care of the tires on this big fleet of delivery trucks the same principles of efficiency that they employ in conducting other departments of their business. And here's the way they do it.

Each truck driver is required to inflate his tubes every morning to a prescribed pressure (90 lb.) before starting out. Then on his return in the evening he applies a gage to determine the pressure. If this has fallen to or below 70 lb. note is made of the fact. The next morning the tires are again inflated to the maximum pressure and the car sent out for another day's work.

If a similar loss is noted at the end of the second day, the tire is removed and the inner tube examined and repaired if the damage is slight. If the inner tube shows signs of weakness or liability to blow out, it is discarded and a new one put in.

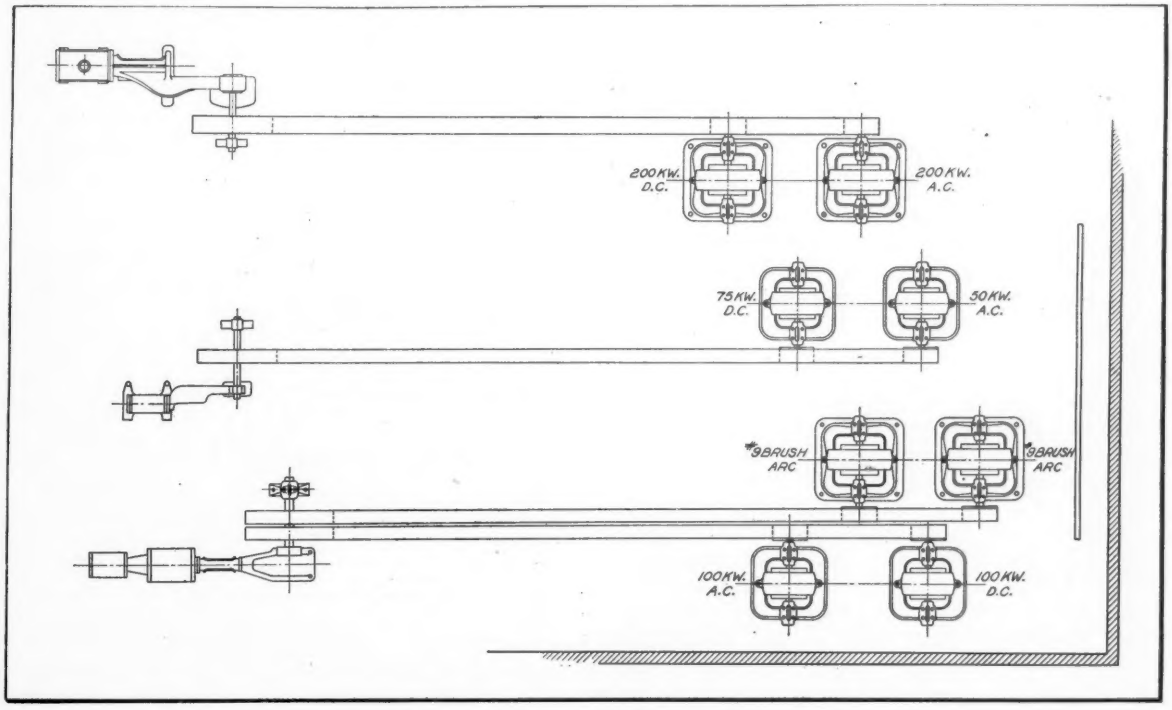
Rim cuts and blowouts are unknown. And punctures occur much less frequently than where similar precautions are not taken.

Another advantage gained by this means is an increase of 60 per cent in the average mileage received.

Poor Engineering and the Result

By Wm. Westerfield

IN A little city of about 14,000 people I found the installation shown in the accompanying figure. The principal equipment in the engine and dynamo room consisted of 1 500-hp. Corliss engine tandem connected by belt to 1 200-kw., direct-current generator for railway work, and 1 200-kw. alternating current generator for lighting service. The other large set of machines consisted of a 500-hp. tandem compound, single valve engine 16½ and 35 by 24 in., connected in the same manner as the Corliss to 2 No. 9 Brush arc generators from one flywheel, and from the other wheel driving one 100-kw. direct-current, and one 100-kw. alternating-current generator. Between these 2 larger sets was an "old timer" Corliss 12 by 42-in., belt connected to 1 75-kw. direct-current, and 1 50-kw. alternating-current generator.



PLAN OF POORLY ARRANGED GENERATING MACHINERY

This plant supplied current for the city lighting, and also power for the operation of the street railway system. In considering this installation, I believe that some preliminary observations are in order. The engines were not protected in any adequate manner from injury from water that might accumulate in the piping system or be drawn from the boilers in case of foaming or priming. While one of the engines,—the single valve—was provided with a steam separator, it was not connected up so as to be effective, as the drain was not connected into a trap, and the separator was never discharged except when the engineer or oiler happened to feel like going around and opening the drain valve; the other engines had no protection at all.

Some time after I first saw this monstrosity, the single valve engine was wrecked. It was stated by the engineer that "the governor must have become deranged and allowed the engine to run away." The facts were that the engine had once before been wrecked "from some mysterious cause" and the frame was cracked in several places, showing that the "mysterious cause," whatever it was,—and most engineers will have little trouble in guessing what it was,—had developed in the engine a disposition to separate itself in the middle.

It was most likely that the piston and connecting rods, in trying to straighten out, in which effort they were helped by the stored energy in the flywheels, which were very heavy, found something in the way of their doing so, and we must be pardoned for having a strong suspicion that this something was water. The damage in this instance was repaired by the builders who supplied new parts except the frame, which was patched up. The last wreck, however, which was widely noticed by the engineering press at the time, was too complete to allow of patching. In addition to wrecking the engine, the engineer in charge of the night shift was killed, and the engine and dynamo room partly demolished.

There are some interesting things in this equipment. With the exception of one machine, the alternating current generators were all of an early make, and as usual

with these old machines, which were made before the principles of alternating current design were fully understood, they ran hot, in fact, to one unaccustomed to them they would be thought dangerously hot.

There can be no question as to the quality of the insulation used in these early machines, for the temperatures at which they operate continuously would destroy the insulation of present day machines. These old machines have been in operation for many years, and it attests the care bestowed upon their construction that they are still in service, and doing what they were designed to do.

What particularly concerns us in this plant is the impossibility of economical operation. The Corliss engine was employed during the day from 6 a. m. till 11 p. m. in driving the 200-kw. alternating-current, and 200-kw. direct-current generators. The direct-current machine supplied current at 550 v. for street railway operation, and was helped out during the greater part of the day by the small direct-current generator driven by the small engine, the small alternator all the while running idle. The 200-kw. alternator carried the day load, and it is safe to say that the useful load on the machine during three-fourths of the time it was in operation, was less than the dead load, as it is well known that the electrical and mechanical losses in a machine are almost as great when lightly loaded as when operating under rated load, which makes the losses very excessive when operated under very light loads.

Let us suppose that the electrical and mechanical losses equal 10 per cent of the rated output of the generator, which would be far too low, then when operating this machine on a 20-kw. load, which was done often during the daylight hours, the losses were equal to the load. Added to this, we have the small alternator running without load, which introduces another serious source of loss.

It will be noticed that the single valve engine is furnished with 2 flywheels, and that from each of these, 2 machines are run by means of belts in tandem. It will also be noticed that the cylinders of the engine are proportioned for a steam pressure of 175 to 200 lb., while the pressure carried in this plant was 145 lb. A casual observation will lead one to think that some one has tried to see how many machines could be belted on one engine without using a counter shaft, and incidentally, to see how little output could be had from a given amount of fuel or steam.

There was plenty of condensing water from one of the largest rivers in the country, and the temperature was favorable, and the lift low, so that there was every opportunity to run the plant condensing, with a good vacuum. The condensing apparatus consisted of 2 surface condensers having 800 sq. ft. of cooling surface each. When both of the larger engines were running the vacuum would be anything from 12 to 18 in., and sometimes when the load was lighter the vacuum would be as high as 20 in. It could not be expected, of course, that the very highest vacuum would be possible with one of the condensers when the peak load was on, and both large engines were running, but there was no reason why the second condenser could not have been used at this time to advantage. Also there was no reason why with a load of say 600 hp., one condenser should not have been sufficient to maintain a vacuum of 25 or 26 in., if they were in first class condition.

The engineer in charge of this plant boasted of what he had saved the company through the installation of this out-of-date apparatus instead of up-to-date machinery, installed in an up-to-date manner. It was true that once in a while a belt would get mixed up in the engines and once or twice took a turn at the switchboard, but of course these little things did not seriously affect such giant economies as were being obtained in the operation of this plant!

As showing what such economies lead to, I will say that the company has lost out with the people of the city, has failed to secure renewal of franchise for street railway, and has lost the contracts for city lighting, and a new company is on the ground to supplant it.

New Inspection Method

THE whole art of boiler inspection rests upon the possibility of detecting nearly every sort of dangerous boiler defect while it is still in an incipient stage, or at least before it has progressed far enough to produce an accident.

Probably the hidden crack which forms under the overlap of a joint has been more fruitful of destruction and less open to detection by preventive inspection than any other boiler ill.

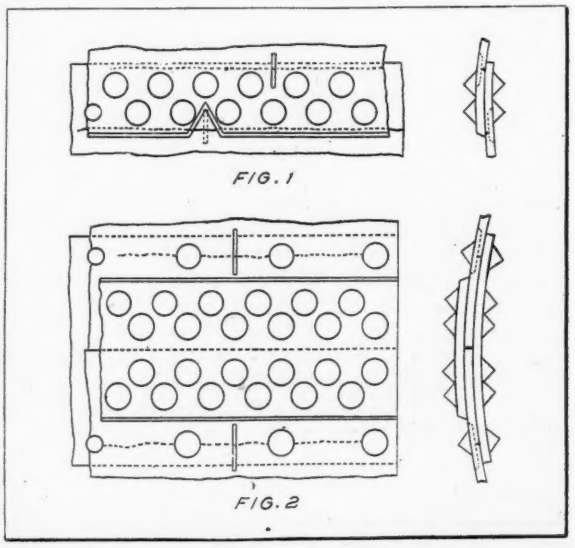


FIG. 1. NEW INSPECTION METHOD APPLIED TO A LAP SEAM
FIG. 2. METHOD APPLIED TO A BUTT JOINT OF THE WIDE INNER STRAP TYPE

S. F. Jeter, Supervising Inspector of the Hartford Steam Boiler Inspection and Insurance Co., has recently patented a method for rendering the detection of seam cracks more certain. His process consists in cutting narrow grooves or slots nearly through the plate, and at right angles to the probable course of the crack, at points where cracks are liable to form, so that a crack will reach the bottom of one of these slots and either show up to the eye of the inspector or develop a leak which will give warning, while the plate still has a large part of

ts original thickness, and before the structure has weakened to the explosion stage. This is shown in Figs. 1 and 2. V-shaped notches may be cut in the calking edge of the overlapping plate to uncover the region in the underlying plate subject to crack formation, dependence being placed on the slots to give warning if the crack develops in the overlap. Such notches or slots will not weaken a joint appreciably or reduce the safe working pressure if they are cut at intervals of a foot or so along the longitudinal seams.

The method is analogous to that adopted for the discovery of fractured staybolts. Here also we have a type of defect which could often be discovered through the agency of the inspector's hammer, owing to the vibrations which light hammer blows set up in a factured bolt. So much uncertainty attached to this method, and so much skill and experience were necessary before an inspector could trust himself to order partly fractured bolts replaced, with the attendant expense and the discredit which he would receive regarding his ability if it should prove that he had marked sound bolts for renewal, that nearly as many staybolt troubles occurred in inspected as in uninspected boilers. All this has been changed in a large measure through the practice of drilling telltale holes in the ends of the bolts. The holes need not extend more than a short way through that part of the bolt in the supported sheet, as nearly all the fractures occur just inside the stayed sheet, and at the end of the bolt holding the thickest steel, where the destructive bending is largely concentrated. Here also, the weakening of the bolt by the hole is trivial, while a leak gives early warning of the formation of a crack.—The Locomotive.

Jeremiah Judson, C. E.

Some Rapid Installation Work

I SEE that Hell & Highwater have taken advantage of the approach of winter to put in a couple of new boilers and have shut the plant down tight and laid all the men off, so that they will not be able to put anything in the Christmas stockings but their foot," breezed Cadwell as he burst into the meeting hall one evening early in December.

Helberg & Highwalder was the name of a firm doing business to the extent of one leaky tubular boiler and an overloaded rickety Corliss engine, and this miscellaneous aggregation of junk furnished the necessary "go" in a "continued-next-year-if-we-get-enough-money-ahead" plant, that made a few of each, of nearly all manner of machines that are used to make the farmers rich, and independent as a hog on ice.

They made a few treadpowers, a hundred or so feed-cutters, a few carloads of woodsaws, cornshellers, feed grinders, fanning mills, and a limited edition of "4-cylinder hayburner horsepowers," of a size that appeals to farmers to hitch a span of mules to when they want to saw wood or cut feed. Then they made a choice pocket edition of a threshing machine, of a size that might almost be sold with a profit at the 10 cent store or given as a premium with a can of baking powder.

It seemed that they made a few of one thing till the men got tired and wanted a change. Then they would switch over to harrows, horserakes, stoneboats or wheelbarrows for a few days to keep the boys goodnatured, —till the next time.

Old Pete Pfiffinheisler was the engineer. He managed to carry the load for 2 winters after the original promise for a new plant. The boiler had been bagged twice, and induced to hold in "just a little while longer." Finally the time arrived when it was necessary to do something for power, and that, almighty sudden.

They waited all summer when the weather was fine, and just after Thanksgiving they jumped into the thing with both feet, ordered 2 new boilers, and tore the side out of the building to make the necessary changes, all in one day. The men were laid off for 3 weeks. By that time it was fully expected that the boilers would be made and delivered, installed, dried out, and everything going again according to Hoyle. But they received a few jolts entirely unexpected. In 3 weeks, the sheets for the boilers had not been received from the mills. The old boiler had been consigned to the scrap, so there they were, with zero weather zipping around the corner, no boilers, no men, no prospects, no nothing but trouble, and that a plenty.

The firm of Helberg & Highwalder was a standing joke in the village and it was but natural that the firm name should eventually be abbreviated into the one used by Cadwell as he entered the lodge rooms the night in question and announced the news that the firm's sprinkling system had turned into refrigeration coils, and that the insurance people were raising the rates "something fierce," and the manager was fast getting "nervous probation."

"Well, gosh ding 'em, it serves 'em right," spoke up Martin O'Conner, who had been a silent listener. "These people who are always waiting for a pleasant day to buy a chain for the dog, get bit sooner or later. Serves them right. Why didn't they get things all ready and then go to it?"

"Yes," chipped in Ed Anderson, "that is half of the battle these days,—getting good and ready. Ain't that so, Jerry?"

Jerry unhooked one knee from over the other and hooked them up the other way. Then he lit his pipe, and after insuring a draft of about 4 in., spat vigorously at the leg of the stove and continued.

"Half the battle? Why, man, it's ALL of it. You can drill more holes in the semi-annual dividends by lack of preparation than a good fire with no insurance," and he hitched his chair around into a more comfortable position that was a sure forerunner of a story.

"Well, sir," he began, after ramming another charge of alleged tobacco into his pipe, "that reminds me of a little experience I had one time,—let me see, oh, I don't know how many years ago, but it was when I was a young fellow, and I was running 'ingine' at a small furniture factory.

"Volumes might be written about that wonderful job, the engine, the boiler, or rather the tank full of scale, and the smokestack. But it's enough to say here,

that the stack looked like the ones on some of these European cruisers after the enemy had bounced 4-in. shells through them for a spell.

"The load was heavy and my predecessor had helped out by chipping an eighth of an inch off the lap of the valve on the old sawmill engine, which insured a healthy exhaust. So, to keep the water from getting stagnant in the kettle, I wrapped the rusted sections of the stack in asbestos paper and it helped wonderful, till the old man intimated that an asbestos stack was cheaper than a steel one, so I quit the paperhanging business.

"The stack stood on a brick footing about 12 ft. high near the main building, an elbow breeching connected the boiler to the brick base inside the boiler-room. So the old man was prevailed upon to buy a new stack and demurred at length till it was apparent that he would soon have nothing left of the old one but the hole and the guy wires.

"He asked my opinion on the length of the old one, and when I said 40 ft. he disagreed with me, as usual. The boss was a regular welsh rarebit,—he didn't agree with anyone. So when he said that it looked like 50 ft. to him, why, I waived my rights as a guesser and we got a 50-ft.

"In due time the new 12 by 36 Corliss engine arrived, and then we began to excavate in the adjoining room for the foundation. Right here the old man wanted me to build a pier up in an old cistern to support the cylinder, as he was opposed to wasting space. Then Providence came to my rescue by presenting the old man with a well developed case of the grippe, with the password thrown in. He came down to the works again just as we started to lay the first stone in the pit and broke a spring hanger again, going back home for another 2 weeks. His idea was to bolt the engine to a few railroad ties. Then he had another stroke of apple perplexity,—I guess that is what it is called if you are wealthy.

"While he was home the second time, the new boiler arrived, a 60-in. by 14-ft. tubular. As this was to stand where the old one was, I had to do some figuring. The old one was a firebox boiler, on skids, with the old engine standing right beside it. It was out of the question to shut down the works till the new one was installed, although the old man figured that this was the proper idea.

"It was now December, and 16 below zero. We wound up a rush order on a Monday noon. That morning, a gang of future aldermen had knocked the end out of the boiler room and it was some cold. The injector and a running engine soon reduced the steam after shutting down and by the time the boiler was empty, the superintendent had extricated the dome of the new boiler from under the flat car where his inexperience had landed it, and with his crew and tools, we soon had the old boiler up on rollers, and headed out the hole in the wall, behind a team of horses on a tackle.

"Then we switched back, like railroading up the mountains, and landed the boiler outside the building, taking care that the old breeching elbow would connect with the stack base by cutting a new hole. A little mortar obtained from a neighboring firm doing some mason work fixed us up and it was a small job to run the steam pipe through a convenient window ω the old engine and knock a pane of glass out of the skylight for the exhaust. The water was connected with due regard for the weather.

"Wednesday noon, we started up again—just 2 days —and after that, a shed was thrown around the boiler to keep off the thickest of the weather. Then we excavated the trenches for the new boiler, and ran it in on rollers, and hoisted it into place. The first work of course was to brick up the end of the building; making some changes in the plans as required.

"When it came to bricking up the new boiler, we had to leave a course of brick out of the side for several square feet for the old engine to project into for the time being. We built a close house over the old scrap heap, leaving a hen hole where I wiggled in twice a day to squirt a little oil on at random in the dark. Only the throttle, the governor and the belt were visible from the outside.

"The boiler once in place, the new steel stack up, etc., I took the measurements for the main steam piping and the exhaust connections. Making a drawing, I pried $5 from the firm, went to Milwaukee with it and fully persuaded a pipe concern to put 6 machines on the job, making up all connections and flanges as I directed, right in the shop, and furnishing the long sweep elbows, so that when I connected up all I needed was a chain tong and a monkey wrench.

"In the meantime, the new engine had been set up, the stub end shafts put up, extending through the wall into the works, and the rope drive put on. Even the oil cups were filled ready to cut loose. At 12:30 that day of the storm, our teamster unloaded the pipes at the works, and we went at it. I didn't do very much myself except the heavy bossing; but with several gangs working at several places, we got all the pipe up and had the new engine blown out and running by 4 p. m., and the erecting engineer left that night on the first passenger train that had been in town for nearly 36 hr.

"I got ahead of my story somewhat. I first bought the necessary valves and connections to put on the new boiler, leaving a gate valve and flange leading to the new engine and another connection for the temporary use of the old one. After drying out the setting, I got up steam to boil out the grease, and filled up the boiler with fresh water. One Sunday I changed the steam pipe from the old boiler to the new one.

"So on a Monday I was running the old engine with the new boiler and the pressure being 125 instead of the 85 (if we had it) on the old boiler, of course the old engine sailed right along. Then the old man wanted to take the new engine out and sell it again because he said we didn't need it.

"So you see, boys, we already had the new boiler in service when the piping arrived.

"Well, at last the great day arrived when we started up again, having put in a new Corliss engine, a tubular boiler and double rope drive to replace an old rickety slide valve engine, a leaky firebox boiler, and a single burned leather belt, and lost only 2 days actual running time as far as the power end was concerned."

Refrigerating Effect of Ammonia

GAINS IN EFFICIENCY OF SYSTEM MADE BY COOLING AMMONIA. BY A. G. SOLOMON

THE refrigerating effect of ammonia is a question that does not often come up for discussion, and it seems to be rather mixed up and puzzling when first gone into.

By looking into this subject closely we shall readily see why an ice machine does more actual work at a high back pressure or high temperature in the evaporating coils than otherwise. We also shall see how we gain greatly in cooling the liquid ammonia as much as possible before it passes the expansion valves. Consider a plant operating at a back pressure of 30 lb., corresponding to a temperature of 17 deg. F. in the evaporating coils; and with the liquid leaving the condenser at a temperature of 80 deg. F.

The latent heat of vaporization of ammonia at 17 deg. F. temperature is 545 B.t.u., the specific heat of the liquid being taken as 1. The temperature of the liquid is to be lowered from 80 to 17, or 63 deg. F., then,

$545 - 63 \times 1 = 482$ B.t.u., which is the refrigerating effect of 1 lb. of ammonia per hour under the stated conditions.

Leaving the condenser temperature still at 80 deg. F., but lowering the back pressure to 15 lb., with a corresponding temperature of 0 in the evaporator, we find that the latent heat of vaporization is 555 B.t.u. The temperature of the liquid must be lowered 80 deg. F., when,

$555 - 80 \times 1 = 475$ B.t.u. per lb. per hr., a difference of 7 deg. caused by lowering the back pressure 15 lb.

Now we will see the gain in cooling liquid from 80 to 70 deg. F. before it is allowed to pass the expansion valves.

Take the zero temperature in the evaporator again, with its latent heat of 555 B.t.u. We have all the conditions the same except that the liquid only has to be cooled 70 instead of 80 deg., then,

$555 - 70 \times 1 = 485$ B.t.u., which is a gain of 10 deg. for every pound of ammonia evaporated per hour.

It is understood that we cannot carry the back pressure desired, as this is governed by the temperature of the coolers or ice tank. We can, however, get the temperature of the liquid ammonia nearly as low as the temperature of the coldest water available. In the double-pipe condenser this is accomplished by keeping a full charge of ammonia in the system and keeping out all permanent gases by purging and circulating as much water as possible. With a full charge of ammonia and no permanent gas we can circulate the ammonia so slow through the condenser that the liquid will leave at just about the temperature of the incoming water.

With the more common type of atmospheric condenser, the counter current effect is not taken advantage of and the liquid leaves the condenser at a temperature from 8 to 15 deg. F. higher than the water when it first comes in contact with the hot upper pipes of the stand, the water being heated in its downward passage.

Take the case of an ice plant which has a limited amount of cool water and where a cooling tower is used. The cool water is, as a rule, either allowed to flow into the reservoir, where it mixes with the water from the cooling tower, or it is pumped over the condenser, together with the cooling tower water. Either way in which this cold water is used the liquid ammonia reaches the expansion valves at a temperature much higher than is really necessary. The cold water can be used as a medium for cooling the liquid after it leaves the condenser. A double-pipe cooler can be used, but other devices do good work and cost little.

Following is a plan which is simple and inexpensive, and has proved beneficial. Water from a well having a temperature of 64 deg. F., was allowed to flow into the reservoir, together with the water from the cooling tower, which had a temperature of from 86 to 90 deg. F. The ammonia leaving the condenser, which was on the roof about 40 ft. directly above the liquid receiver, often reached a temperature of 96 and even higher. The liquid line was of 2-in. pipe, with a 4-in. pipe around it. Caps were used at the ends and packing glands were used to prevent leakage where the 2-in. pipe came through the openings. Inlet and outlet openings of the 2-in. were each made in the 4-in. pipe, the inlet at the bottom and outlet at the top.

Water from the well was allowed to flow into a wooden tank, from which it was pumped through the 4-in. casing and then over the ammonia condenser. This simple arrangement gave a liquid ammonia temperature of between 68 and 75 deg. F., according to conditions. We could almost judge the amount of ammonia in the system by the temperature of the liquid. When the system was full this temperature was about 68 deg. F., but when the charge was shy, the temperature rose to about 75 deg. F. This difference is explained by the speed at which the ammonia is drawn through the liquid receiver and not having sufficient liquid in the condenser to act as a seal.

Cooling liquid in this manner is a direct gain, as no additional work is put on the ammonia compressor.

Nearly all ice machines can be crowded some, but the ice plant is limited in its output by the number of cans or the coil surface in the tanks. Where the coilage in the tanks is small compared with the amount of gas that the compressor is able to handle, a low back pressure will result. In such a case, the use of a double-pipe liquid ammonia cooler using direct expansion is advisable. By reducing the temperature of the liquid as low as possible before it reaches the expansion valves, the efficiency of the evaporating coils is increased; that is, they will handle a heavier and more heat absorbing vapor than they would if some of the ammonia became superheated in doing work cooling itself.

Whatever the temperature of the liquid ammonia at the expansion valves is, it must be lowered to the temperature of the evaporating coils. Until this low temperature is reached no work is done on the brine, but rather the ammonia is working on itself. This cooling of the ammonia must be done by a certain per cent of itself, and the resultant gas which is evaporated passes through the full length of the coils without doing any work but still taking up room and in that way cutting down on the efficient cooling surface of the coils.

Efficiency in the Engine Room*

IMPORTANCE OF ECONOMICAL OPERATION; COMPARISON OF STEAM ENGINE AND REFRIGERATING MACHINE. BY J. E. PHILLIPS

TO obtain the most economical results in operating the refrigerating plant, we must diversify our efforts, not confining ourselves to any particular part of the power or refrigerating plant, but considering every detail of every part of the combined plant. What we are all after is to produce power as cheaply as possible and use as little of it as necessary. There is as much to be gained in the average ice plant by using just as little power as is necessary, as there is by making it cheap. It is this combination that counts for efficiency.

The engineer is just as important a factor in the power and refrigeration field as the machinery. The machinery, to operate economically, must be of the right design, and to know when it is operating economically, and keep it operating economically, requires the services of an efficient engineer.

The writer will not discuss the cost of producing power in this paper but will endeavor to point out some of the unnecessary and avoidable losses that should everlastingly be combated. The old-time saying, and a true one, that "there is more to be saved in the boiler room than in the engine room of the average power plant," can equally be applied to the ice tank or ammonia evaporator of the refrigerating plant. The ammonia evaporator fills the same identical place in the refrigerating plant as does the boiler in the power plant. The analogy between the heat engine and the refrigerating machine is this: The steam engine receives heat from the boiler, converts part of it into mechanic work in the engine cylinder, and throws away the difference in the condenser or atmosphere.

The ammonia in the compression refrigerating machine receives heat from the brine tank or cold room, and receives an additional amount of heat from the mechanical work done in the compressor cylinder and throws away the sum in the condenser.

STEAM AND REFRIGERATION

THE EFFICIENCY of the steam engine is work done, divided by heat received from the boiler. The efficiency of the refrigerating machine equals heat received from the brine tank or cold room, divided by heat required to do the work in the compressor cylinder.

In the refrigerating plant the pressure in the condenser should be kept as low as possible, the limit depending upon the temperature and quantity of available water, and the back pressure or suction pressure should be kept as high as possible, the limit depending upon the fixed temperature to be maintained in the brine tank, narrow limits between these pressures being as important to the efficiency of the refrigerating plant as wide ones are to that of the steam plant, in which the economy increases with the range between the boiler and condenser pressures.

To obtain the highest suction or back pressure within the limit of the temperature to be maintained within the brine, depends upon the method of applying the cooling effect of ammonia; and this general principle can be borne out as giving the best results for the least square feet of pipe surface used in the refrigerator rapid circulation of the brine and have as much ammonia liquid, and as little ammonia gas, in contact with the cooling coils as possible. The reason for this is that gas transmits heat only about 1/30 as fast as liquid. The best refrigerator of today is the shell type brine cooler, where the liquid ammonia boils in contact with pipes through which the brine to be cooled is rapidly circulated.

In the writer's opinion, the nearest approach to the above-mentioned brine cooler is the so-called flooded system. Its greatest disadvantage is that it does not have a quick enough liberating surface for the vapors of evaporation.

To obtain the lowest condenser or discharge pressure within the limit of the temperature and quantity of available water supply, depends upon the design of the condenser and the effective application of the cooling water. Recently condensers have been invented by Louis Block and Mr. Shipley, wherein sufficient condensed ammonia is retained to absorb the incoming gases, the absorption of the heat being direct between the liquid ammonia within the pipes and the water flowing over. Both of these condensers are said to be effective and that there is only a few degrees difference between the temperature of the liquid ammonia leaving the condenser and the initial temperature of the cooling water; consequently, a low discharge pressure.

THE VOLUMETRIC EFFICIENCY

THE VOLUMETRIC efficiency of the compressor is the ratio of the weight of ammonia pumped to the amount calculated from the piston displacement, and depends upon the amount of clearance, area of inlet and discharge valves, and the condition of gas entering the cylinder, whether dry, saturated or superheated; also the provisions made for the taking care of cylinder heating due to compression.

Proper insulation of the various parts of refrigerating plant plays no small part in making it efficient. The refrigerating tanks, the cold rooms, the brine pipes, the ammonia suction lines between the refrigerators and compressors, the liquid ammonia pipes and liquid receiver—in fact, everything that is colder than the surrounding atmosphere, should be properly insulated.

To avoid depression in pressure between the ammonia evaporators and the compressor, the suction lines should be amply large.

Having the above-mentioned parts of the proper design, it only remains for the engineer to keep them in proper form to give the most efficient performance. By keeping the interior and exterior surfaces of the evaporator and condenser perfectly clean, and by the intelligent use of the indicator and the thermometer, the power necessary to produce a ton of ice will be the minimum.

TIME TO make ice is close at hand and if those in charge of plants don't want trouble when it is most unwelcome, a few days spent in going over the entire system will insure more satisfactory operation and suggest improvements.

*Read before Practical Refrigerating Engineers' Association.

The Engineering Foundation

ON Wednesday evening, January 27, 1915, was held in the auditorium of the Engineering Societies Building the inaugural exercises of The Engineering Foundation, established by the United Engineering Society. The initial gift of the Foundation of $200,000, the income only from which is to be used for the purposes of the Foundation, made by Ambrose Swasey, Past-President of The American Society of Mechanical Engineers, was formally accepted at this time. So far as known this is the first instance of a foundation devoted to engineering purposes and this meeting constituted an appropriate tribute to the generous gift which made its inception possible and gave opportunity for expression of the satisfaction and approval which is felt by engineers everywhere at the establishment of a means for forwarding the work of the engineer along the broadest possible lines.

The first address of the evening was made by the chairman, Gano Dunn, who reviewed the history of the Engineering Societies Building, the purpose of the United Engineering Society, and the formation of The Engineering Foundation made possible by Mr. Swasey's gift and stated that the structure of the Engineering Foundation was so arranged that it should be made by a Board of 11 members, of which the President of the United Engineering Society should be ex-officio 1, 2 members from each of the founder societies, 2 from the American Society of Civil Engineers, and 2 from the world at large. In this latter provision the trustees hoped to introduce into the Foundation an outside element and a point of view that would forever save the Board from becoming narrow, and would likewise inspire new ideas.

Mr. Swasey very briefly expressed his appreciation of the cordial manner in which the announcement had been received. He believed that the meeting was also evidence of the appreciation felt of what had been accomplished by the United Engineering Society and the work which they had done in planning and bringing about this Foundation.

Dr. Henry S. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching, spoke upon the significance of the gift and its meaning for engineering science and civilization. Great numbers of research institutes already exist in Europe and America, but never has such an agency for research been placed in the hands of a group of engineering societies. In the sense the word research is used in this Foundation, he thought, it means the attempt to formulate and solve those problems of science which touch most directly the comfort, the happiness and the progress of the nations and of the world.

Robert W. Hunt, Past-President of the American Institute of Mining Engineers, paid a personal tribute to Mr. Swasey, as a lifelong friend, and said that it is one of the few certainties of this world that the greatest earthly happiness comes to those who have made others happy.

Charles McDonald, Past-President of the American Society of Civil Engineers, outlined the research work which had been accomplished by the American Society of Civil Engineers, and said that this society with its series of committees welcomed the efforts to be made through this gracious gift to The Engineering Foundation. His society would be glad to solicit such assistance as might be needed for the general good of the profession. No matter what organization he was representing, he wished to be considered at this time as a member broadly of the whole profession.

Dr. Alex. C. Humphreys, Past-President of The American Society of Mechanical Engineers, formally accepted Mr. Swasey's gift in behalf of the Board of Trustees of the United Engineering Society. He quoted the by-law of the Society which covered the administration of such a fund.

Biography of Ambrose Swasey

AMBROSE SWASEY, the donor of the initial fund for the Engineering Foundation, is widely known as a member of the firm of Warner & Swasey, of Cleveland, Ohio, prominent machine tool builders and builders of telescopes. Among the instruments which they have designed are the famous Lick, Yerkes, and United States Naval Observatory telescopes, as well as the great 72-in. reflecting telescope for the Canadian Government, which is now under construction. Mr. Swasey is known also, in addition to his engineering achievements, for his practical efforts toward scientific education and the advancement of the profession. His gift for the establishment of The Engineering Foundation is in line with these undertakings, which may be destined to outlast his fame as an engineer.

Ambrose Swasey was born in Exeter, N. H., his ancestors being among the early settlers of New England. He received his education in the district school and at the age of 18 entered upon the machinist's trade in Exeter. In 1870, in company with his present partner, Worcester R. Warner, he entered the employ of the Pratt & Whitney Company, at Hartford, Conn.

While in charge of the gearing department, he invented and perfected the epicycloidal milling machine for producing the true theoretical curves of the teeth of gears, and a few years later invented an entirely new process for generating and cutting spur gears, which proved a practical solution of the very important theory of the interchange system of gearing. In 1880, Mr. Swasey, together with his present partner, established in Cleveland, O., the business which has since grown to such large proportions.

The manufacture of meridian circles, transits and other astronomical instruments of extreme accuracy and precision has formed a large part of the firm's work, and in the designing of all these instruments Mr. Swasey has taken an important part. Mr. Swasey is the inventor of a number of instruments used by the Government in its coast defense, including several improvements in the construction of range finders.

Many honors have come to Mr. Swasey for his work and achievements.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Overcoming Trouble with Return Pump and Receivers

THE AUTOMATIC return pump and receiver is now considered a necessary part of a heating system, but there are many plants that lose more money yearly due to the way the condensation is handled than would pay for this up-to-date apparatus.

To work successfully, the piping in any heating system must be given sufficient pitch to allow of easy and certain drainage, and this naturally points to a central point below the lowest coil or radiator where all the returns are collected.

Frequently an open tank is employed, the tank being open to the atmosphere and the feed pumps being located

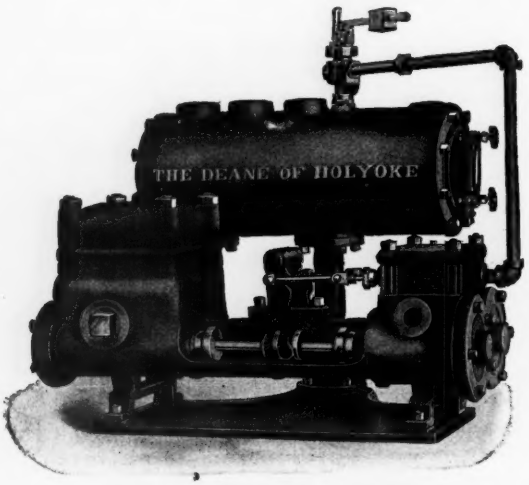


FIG. 1. PUMP AND RECEIVER

below this to receive the condensation and force it into the boilers. Since this method releases the returns from under the pressure it had in the system, much of the contained heat is consumed in evaporating water into vapor that passes into the air.

By providing a receiver into which the returns discharge, and a pump, the speed of which is regulated automatically by the height of the water in the receiver, the returns are not released from pressure and are delivered to the boilers direct, saving much heat.

When a new plant is laid out and a receiver and pump can be used to advantage to return condensation to the boilers, the same pump can be made large enough to act as a feed pump, and by connecting a cold water or makeup water pipe into the receiver, the cost of installation and operation will be reduced.

The mentioned cold water valve should be located where it is easy of access, although the pump and receiver may be located several feet from the boilers.

Figure 1 shows one type of this apparatus. The pump is controlled automatically by the height of water in the receiver, by means of a bucket or float riding on the surface of the water, and a system of levers that operate the throttle valve, Fig. 2.

One reason why these equipments do not give better service is because they do not receive proper lubrication. In many cases, they are located in dark corners, at a considerable distance from the boiler room. The pump ought to have the valve motion and rods oiled regularly and with good oil.

They should also be provided with a good sight-feed lubricator for the steam cylinders, so located in the steam pipe that the oil will pass through the automatic valve,

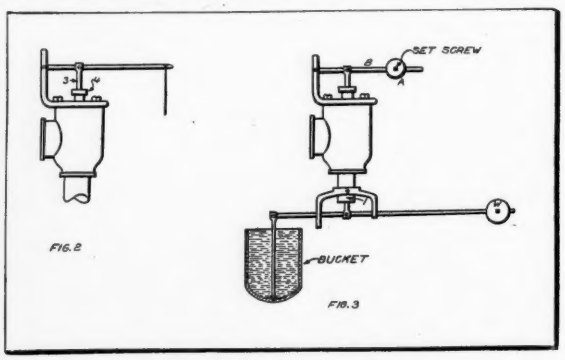


FIG. 2. THROTTLE VALVE
FIG. 3. THROTTLE VALVE WITH BUCKET AND COUNTER WEIGHT

Fig. 2, lubricating and allowing it to move easily, also protecting it, as a valve coated with oil will not cut like a dry one; this is an important consideration, because these valves are usually moved only a little at a time, for when the outfit is in good order, a slight increase in pump speed will remove a large volume of water.

Care must be taken not to tighten the packing too hard on the valve stem 3, and, when the throttle valve is located away from the receiver, as in Fig. 2, the stuffing box, 4, as a little too much friction seriously interferes with the proper operation of the pump. When the packing is too tight, the water line rises considerably, and when the pump is started the speed is high, soon the water is reduced to the usual level; but, due to the sticking of the parts, the speed is not reduced at the proper time, the water is entirely removed from the receiver and perhaps the pump runs away, with liability of, if not actual damage to itself before the steam is shut off.

Some men make a mistake and pack the valve stem at the point 1 in Fig. 3. This is not intended to be packed, since only a little drip will come out here and when packed the added friction interferes with smooth operation.

In this type of apparatus, the weight W, Fig. 3, is to be so located on the lever that it will just balance the weight of the bucket when full of water, as shown. The weight A on the lever B is intended to regulate the height of the water line in the receiver. The water line should be carried about 1 in. below the center. A water glass is a valuable fitting and generally is supplied with the receiver. Care must be taken to keep it clear. The practice of some of shutting it off on the ground that should the glass break and no one be near to shut it off, damage to material would result and a mess be made, should not be accepted as sufficient reason for having the glass out of commission.

As hot water cannot be lifted by suction, it must run into the pump cylinders by gravity, and to accomplish this, the receiver is set higher than the pump. This makes a head of water available to raise the pump valves

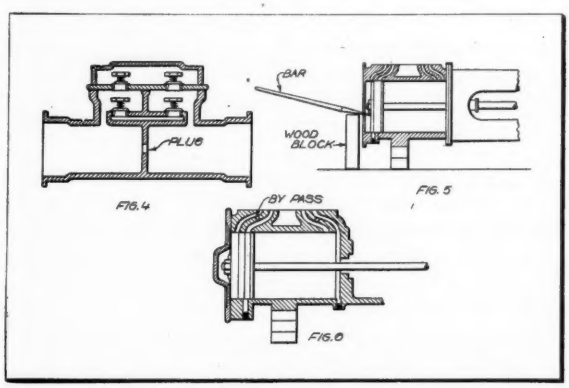


FIG. 4. SHOWING LOCATION OF CORRODED PLUG

FIG. 5. SHOWING HOW PINCH BAR WAS USED TO TEST FIT OF PISTONS

FIG. 6. SMALL HOLE UNITING STEAM AND EXHAUST PORTS

and fill the cylinders at each stroke. When, for any reason, the cylinders do not fill, the piston will travel a part of its stroke with little, if any, load at a high speed, then on coming into contact with a solid body of water, a pound is produced. In some cases, when very hot returns are to be handled, the receiver has been raised to advantage. Usually a light pressure only is available to lift the pump valves, therefore light weight valves of suitable material for hot water only should be used. When the valves have a tendency to rise too high and stick, a spring is usually provided to limit their travel and assist in closing them. The tension on all springs should be as nearly the same as possible.

When the valves have the imprints of the ports on them so that they leak, they can in many cases be turned over and further service rendered.

At one time a duplex pump connected to a receiver pounded heavily, and after an examination of the water valves showed the trouble to be elsewhere, it was found to be due to the tie rods that connected the plungers (as it was an outside packed pump) rubbing hard in the grooves in the cylinder heads through which they moved. These were chipped and no further trouble was experienced.

On another occasion, a pump pounded hard on one end of the stroke on one side only. After looking at the common places for trouble, it was suggested that the water packing be removed from the plungers. On the side where the trouble was, it was found that the plug screwed into the division that separates the 2 ends of the cylinder, Fig. 4, had been eaten by corrosion and so the water raced from one side to the other. This hole was used to rest the boring bar or the core when making the machine in the shop.

Tapping the hole out and inserting a new plug cured the trouble. If the glands on the packing are screwed up too much, the friction will be so great that the speed will be reduced and the water rise above what good practice calls for.

The receiver should always be provided with a relief valve set at not over 10 lb. to relieve the receiver of any pressure above that point. A bypass should be provided around the apparatus that the returns may be run off while repairs are made to the outfit.

It is well to extend the suction pipe several inches above the bottom of the receiver when the construction will permit, to prevent grit and the like, which is always coming down from a system, entering the pump cylinders and causing trouble.

When the location of the outfit is such as to be favorable to the accumulation of grit, if the pump is covered with a bag or the like, the dirt will be prevented from gathering in the rods and cutting them, thus prolonging the life of the packing.

The writer has provided an oiler made from an empty cartridge shell, with a band around it, which in turn is flattened out and held under one of the nuts on the cylinders. This cup is filled with oil, a piece of lamp wick is used to immerse one end in the oil and the other end rests on the rod. The life of the rod packing is thus increased considerably.

One of our smaller automatic pumps began to pound and after the water end has been gone over carefully, the cylinder heads were removed. A pinch bar was used to try the fit of the steam pistons in the cylinder, as shown in Fig. 5. This showed the packing rings to be weak and not in contact with the walls of the cylinder. The rings were removed by inserting sheet metal shims in the counterbore and the inside of them peened with a hammer, much further service being gotten out of them, and the pound having vanished.

Another case was where a 6 by 4 by 6-in. automatic pump developed a pound on the head end in one cylinder. After a general examination the cover of the steam chest on that side was taken off and the valve removed.

In this particular pump, a small hole united the steam and exhaust ports, as shown in Fig. 6. It seems that there was a soft place in the casting, and the continual passing of the steam cut out the hole large so that there was no volume retained for compression. After plugging the hole no trouble was experienced.

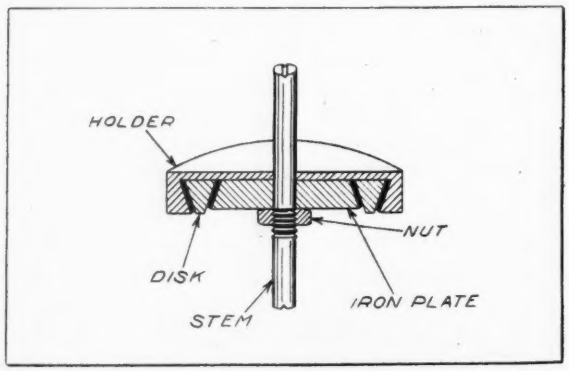
RECEIVER.

A Job that Came Back

THE RUBBER disk in the automatic exhaust relief valve on our 3½ by 12-in. barometric condenser began to leak air, which cut down the vacuum from 28 to 22 in., so I put a lot of soft putty around it, which closed the leak and the vacuum went up to 28 in. again. After that I ordered a new disk to replace the old one, which had been running 6 yr.

In a short time the putty dried up and fell off and the disk began to leak again. So, when we had finished the week's run Saturday noon, I told the boys in the repair shop they had better take off the holder and put in the new disk.

After they had the holder back on again one of the boys came down and said, "You had better start up the circulating pump and try the condenser. A fat chance you'll have of getting any vacuum."



DISK THAT GAVE TROUBLE

I asked him what the matter was, and he replied: "The new boss did the job and it is the first one he has done since he came here. He took the old disk out himself and saw how it went in and the next thing I saw he had got the disk in the holder bottom side up and was driving it home with a lead maul. He then entered the plate in the center with the maul until the nut caught on the stem, and then finished up with a 24-in. monkey wrench; and the face of that disk looks like a section of corduroy road."

Starting the pump, I watched the gage until the hand got almost up to 3 in., but waited in vain for it to go higher. I stopped the pump and went up on the platform to have a look at the job. Between the disk and the seat I could see lots of daylight. The mechanic asked me what I thought of it, and I said, "It certainly is bum!"

He said, "That's right, but what am I going to do about it? I've spoiled the disk and I can't do any more with it. If you can help me out you'll do me a great favor."

Well, I advised him to take the whole thing out again and carry it back to the repair shop and we would see what we could do about it. I looked over the disk, and noticing how hard it was, I thought while talking with the mechanic that perhaps we might true it up. As the stem was centered, I had them put it in a lathe and by taking off several fine chips with an ordinary tool we soon had it squared up as good as a new one.

Then back it went onto the condenser, and when the engine started up, the vacuum went up to 28 in. and has stayed there ever since. And that is how a bum job "came back." But it was rather heroic treatment all the way through.

After this experience, I am going to try to square up my disks when they leak and I think the life of a disk so treated may be prolonged several years. Anyway, it is worth trying. ABRA.

Massachusetts Examination Questions

IN REGARD to the questions asked by A. A. H. and answered by R. E. T. in the Dec. 1 issue, I find some statements in the answers with which I do not exactly agree, and which I think do not answer the questions as would be required by the examiner, although they are partly correct.

1. What is the counterbore of an engine?

After the cylinder has been bored, the ends are counterbored to a diameter of about ¼ in. larger than the barrel of the cylinder. There are several reasons for this. It gives a true surface which is not affected by wear from which a line through the cylinder may be accurately centered in lining up the engine even though the cylinder may be badly worn. The piston overlaps, or should overlap the counterbore which prevents a shoulder being worn in the cylinder at the end of the stroke.

2. How would you center the piston on an engine?

The answer given states in substance that the rod is disconnected from the crosshead and the piston centered in the cylinder, then the distance from the center of the disconnected rod to the bottom guide is measured and the crosshead adjusted to it. This is not right.

With all parts connected up as required to run, remove the cylinder head and turn the shaft to bring the piston nearly to the head end center, remove the follower plate and snap ring to gain access to the adjusting screws, caliper from the turned part of the spider hub to at least 4 equidistant points on the counterbore, and turn the adjusting screws to bring the hub in the center of the counterbore.

After getting the piston central, tighten the lock nuts on the adjusting screws, and replace the snap ring and follower plate. Turn the engine over to the other center.

There are 2 methods which may be used to center the crosshead. One is to place a level on the top of the piston rod near the crosshead where the rod is not worn and adjust the bottom shoe as required to bring the rod level. The only objection to this method is that the engine may not be exactly level, in which case the "leveling spots" on the frame will show it. The other method is to caliper from the top of the rod to the upper guide, which in an over running engine wears very little. Measure this distance at both ends of the guide and adjust the crosshead accordingly. If the guides are of the bored type, and the lower guide is not badly worn, caliper from the top of the rod to the upper guide, and from the bottom of the rod to the lower guide, and adjust the rod until both measurements are the same.

4. Why are wooden or asbestos plugs used in hollow stayholts?

Answer given: "Hollow staybolts are usually used on water legs of locomotive type boilers, and the air passing through them tends to keep them cool and helps supply oxygen to the fire. If too much air is supplied, they might be plugged; or if a bolt was cracked so that it leaked."

He does not mention the use of the hollow staybolt as applied to the boilers which come under the jurisdiction of the Massachusetts law; namely, the Heine, Geary and other water-tube boilers which use hollow staybolts, and which directly concern the stationary engineer.

The hole in the staybolt is not intended for the purpose of keeping the bolt cool or to supply air, but to show the engineer by means of escaping steam and water when the bolt has become broken and is in a dangerous condition. In order to have combustion, we, of course, must have air in the furnace. The greater part of this air should come through the fuel bed, and a small part of it should come in over the fire before the products of combustion strike the heating surface. After the heating surface is reached, the temperature of the furnace is lowered to such a degree that any additional supply of air admitted to it does not affect combustion, but will absorb enough heat units to become heated to the temperature of the gases at the point of admission. This, of course, takes heat that should go into the heating surface. These hollow staybolts are used in the water leg, and in the throat piece above the tubes in a stationary water-tube boiler. Air, on entering at this point, cools the gases and robs the boiler of part of its heat, and produces CO instead of CO_2, or in other words, incomplete combustion; therefore, they should at all times be closed with wood, metal or asbestos plugs.

If the staybolt became cracked and leaked, the escaping steam and water would be drawn into the furnace, as the current of air is in that direction, unless they leaked very badly, and even if the hole was not plugged the leakage might not be seen. But even a slight leakage would be easily discovered by examining the inside, or fire side, when the boiler is cold. In case the bolt was broken, the plugs usually used would be of no use in stopping the leak, and this leak should not be stopped because it is a warning of dangerous conditions. The only objection to plugging these holes is that in case of a broken bolt, the leakage cannot readily be seen unless the plugs are on the fire end of the hole, which is impracticable. Metal or asbestos plugs should be used; wooden plugs are sometimes used on account of the low first cost, but do not last as long.

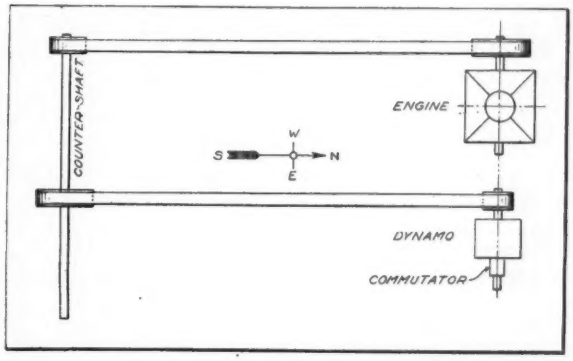
J. C. HAWKINS.

Dynamo Hot Box

I HAVE a dynamo of 110 v. and 60 amp., driven from the line shaft of the mill, to light up a part of it, for a few hours in the early morning and at night daily. It never gave any kind of trouble by heating or sparking; in short, it was working more satisfactorily than any other dynamo we had.

As it was decided that this small dynamo should be worked the whole night after closing the factory, to burn the lamps in the compound and officers' quarters, a small outhouse was erected outside the main factory building, and the dynamo and a vertical engine installed as shown in the figure. Soon the dynamo bearing near the commutator began to get hot, and although a flood of oil was given regularly, it did not cool at all; the bearing on the other side was running in quite its normal condition.

Various methods and many kinds of oil were tried without result. As the dynamo was to be worked for the whole night, it gave so much trouble and worry that I was quite confounded, as for this little machine, 2 men had to stand all night pouring a regular stream of oil on it.



ARRANGEMENT OF DYNAMO DRIVE

Here it should be noted the driving side of the belt, in its original position, was the under-side, while in the new position the driving side was on top.

After working a few days, with much worry and trouble, I thought of driving as it was originally, and to do this the engine was reversed and the dynamo was turned about so that the direction of armature rotation was not changed. With no other change, the bearing, which formerly was getting so hot, ran in its normal condition; and, as it is ring oiling, the attendant, after filling up the oil box, sleeps for a while without fear of getting it hot again.

The reason of getting hot in the altered condition, I think, was the upward tension of the belt, lifting the armature from its position.

I am anxious to know if any readers can throw some light on this.

N. N. BAVA-ADAM.

Correction of Air Pipe Velocity

IN THE editorial comment on the leading article on "Air Lift Plant" in the Jan. 15 issue, figuring the velocity of air in the main pipe leading to the wells, the cubic feet of free air was taken instead of the volume of air in its compressed state. Assuming 1400 cu. ft. of free air a minute, and a working pressure of 75 lb., the true volume flowing would be $(1400 \times 14.7) \div (14.7 + 75) = 229.5$ cu. ft., the volume of the air changing inversely in proportion to the absolute pressure. Dividing this corrected volume by the area in square feet of the air pipe, $229.5 \div 0.196$ gives 1170 ft. a minute as the velocity of the air in the pipe, which is an economical flow and ought not to result in a pressure drop of over 1 lb. per 1000 ft. of pipe. This error and the data for the correction were sent us by the author of the article, Chas. C. Phelps.

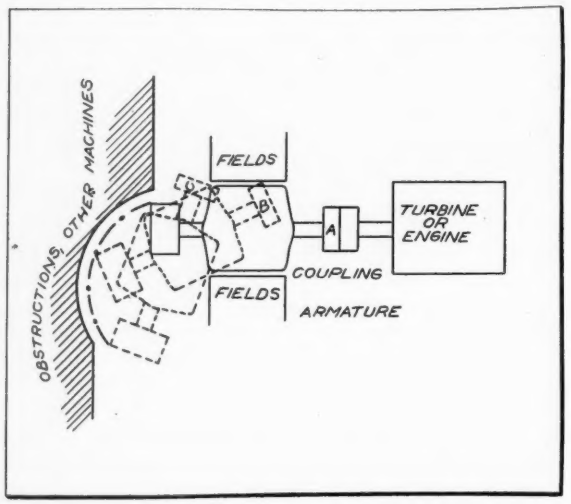
Successful Kinks From The Plant

For Saving Time, Work and Trouble

To Determine Space Needed for Removal of Parts

MANY AN engineer has found himself "up against it" in removing armatures, flues, etc., from machines and boilers, because of the fact that on installation insufficient space was allowed for removal. It is not uncommon to hear of instances where the whole dynamo has to be turned on its base in order that the armature may be removed. When installing, the installer "never thought of that part."

A simple way to determine the exact amount of space needed for removing armatures and the like is indicated by the drawing herewith. There I show an armature



DETERMINING SPACE FOR THE REMOVAL OF AN ARMATURE

in the fields coupled to a steam turbine, with the armature coupling in position A when coupled. At the other end of the shaft is a pulley, which, in a pinch, could be removed, making the space needed for removal even less.

On moving the armature to the left, always keeping the coupling flange in touch with the fields on one side and the armature in touch on the other side, the armature will assume such a position in its travel as indicated by the dotted outline, coupling at B, and the pulley's edge will describe a path as shown by the dot-dash curve. When entirely out, the armature will be in the third position shown, coupling at C. It is therefore permissible to place other machines, a wall, or any other obstruction outside of the dot-dash "obstruction curve."

The best way to determine this curve is on paper. It would be absurd, almost, to take an armature and try it before installing. If blueprints accompany the machine being installed, lay off the fields, if not already laid off, make a paper rotor just the size of the rotor shown on the print and slide it outward, always keeping it in a limiting position as indicated in the drawing. Make pencil marks at the extreme position of the pulley edge, or shaft end, and then, through these marks, plot a dot-dash curve. You can then determine the distance that must be kept in the power house, for the blueprints are always drawn to scale. N. G. NEAR.

Troublesome Plunger; Safe Governor Drive; Simple Valve Grinder

AN OUTSIDE packed double plunger pump was cured from stopping after the former engineer had trouble with it for about 2 yr. First, I looked over the water end. Second, I began to take the plungers out. After I had them out I put them together on the bench. I found them as illustrated.

Figure 2 shows the cause. The square shoulder was worn off the rod and plunger, which made it about ¼ in.

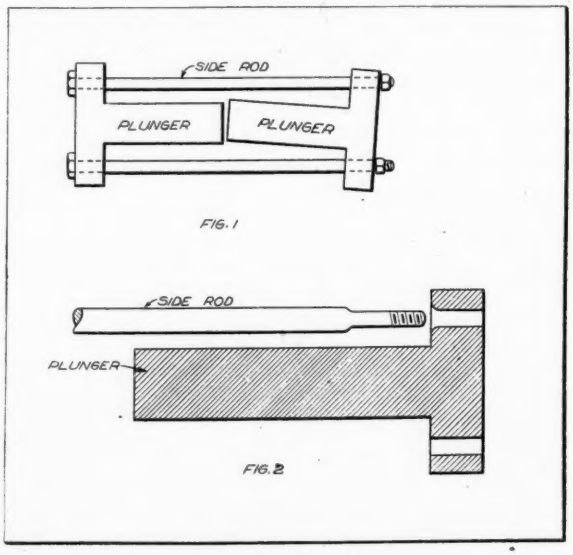


FIG. 1. WHY PLUNGERS CAUSED TROUBLE

FIG. 2. DEFECT OF ROD AND PLUNGER WHICH CAUSED TROUBLE

short. The hole in the plunger was drilled and tapped for a piece of ½-in. pipe. The pipe was screwed in and filed off flush with the casting, and a new side rod. The pump was then put together and it worked as well as when new.

I had charge of an engine the governor of which was driven by 2 belts, side by side. This is a good idea,

because when one belt broke it could be taken off while the engine was running and the other belt would drive the governor. This, of course, prevented a shut-down.

To reseat globe valves on pipe line, take off the bonnet, get a piece of file the length wanted, drill and tap the file to fit the bolt. Put on the bonnet again and put

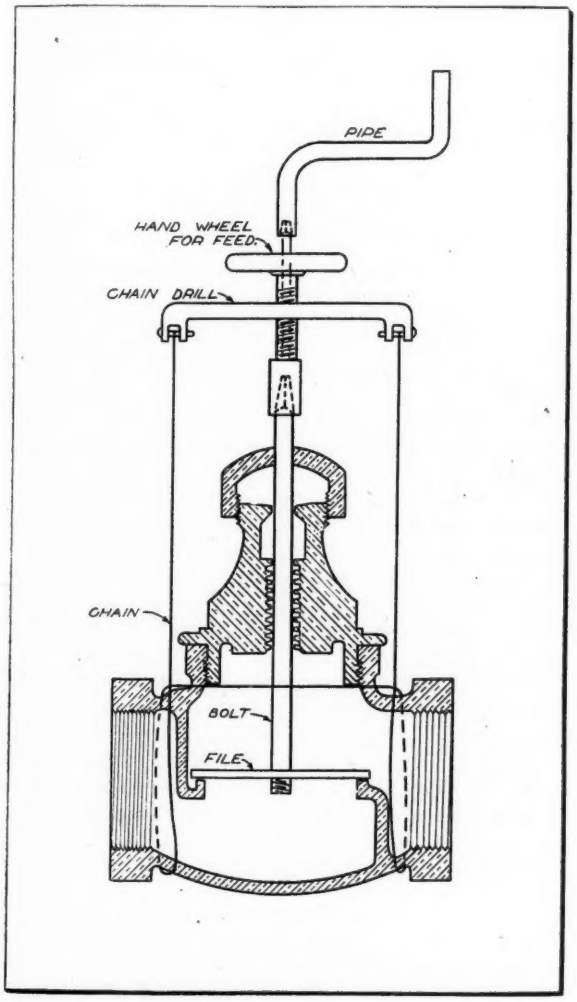


FIG. 3. METHOD OF GRINDING VALVES WITH A CHAIN DRILL AND PIECE OF AN OLD FILE

a chain drill on the square on the end of the bolt. Put the chain around the valve, as shown in Fig. 3. Use a hand wheel to feed the cutter and a piece of pipe for handle. I have reseated several valves this way and find it very handy; it does not require much time to finish a valve with this. WM. CARRIE.

Blueprinting by Faking the Tracing

IN MAKING a tracing of a drawing, it is sometimes necessary to make blank black spaces in order to leave a white space on the print, to be used for filling in dimensions, notes, etc., which are changeable.

This gives the appearance of a doctored print and can be overcome by making the tracing as usual and eliminating the black spaces. Then make another tracing, to be used as a mask, with 2 fitting corner marks, and mark on this mask all the additional data required in the proper positions located from the tracing.

In preparing for blueprinting, the mask tracing should be laid face down on the glass, then the regular tracing laid face down on the mask and print as usual, giving twice the exposure generally used for a regular tracing.

I have found it good practice to paste both mask and tracing together at the corners, having made the mask with a little larger margin than the tracing. This makes it easier for the blueprint boy to handle, and insures correct location.

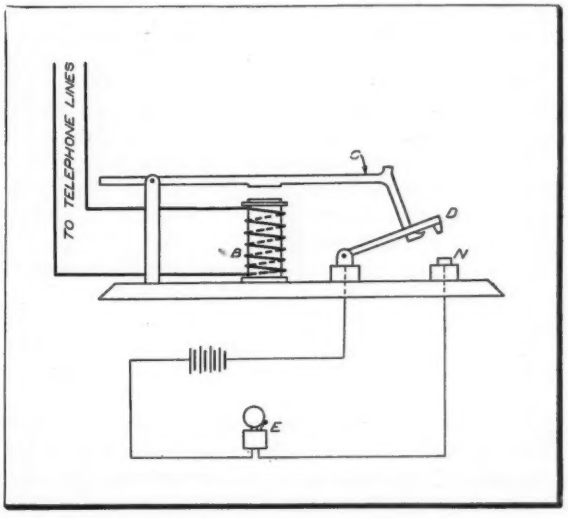
This plan of printing is useful where it is necessary to send prints with proposals on work where dimensions are likely to change and where good prints are desired. It also eliminates mistakes and where many prints are made from the same mask and tracing, it will be a much quicker and cheaper way of doing the work.

H. J. MOYER.

Telephone Signal

CONSIDERABLE trouble was being caused by the engineer's not being able to hear the telephone bell, so I made the arrangement shown in the accompanying figure.

A magnet coil, B, is connected in the telephone circuit so that when the magneto, or bell rings, the current passing through it pulls down the lever, C, letting D



TELEPHONE SIGNAL CONNECTIONS

drop off the hook, thereby making contact with N, and closing the battery circuit, causing the large bell, E, to ring until D is replaced and the local circuit opened.

After this no more trouble was experienced.

GEORGE L. MACLEAN.

ON JAN. 21, a serious fire occurred in the building of the G. B. Essex Brass Works Co., 480 Franklin St., Detroit. There were minor injuries from jumping, and a few burns, but nothing serious. Loss was estimated by firemen at about $15,000.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Inductance, Capacity, Impedance

WHAT IS the meaning of a circuit containing self induction and capacity?

2. What is self induction?
3. What is impedance?
4. What are inductance and reluctance?
5. What is the meaning of "dampens"?
6. What is meant by dead-beat? V. K. S.

A. Frequently, where an electromotive force is causing an alternating current to flow in a circuit, the current may not rise and fall in unison with the electromotive force but may lag behind it. This effect is due to what is known as self-induction, and it is a direct consequence of the variation which the current undergoes.

There is another property of electric circuits which has to be considered in connection with the flow of alternating current, and which, like self-induction, does not enter into consideration of the flow of continuous currents. The property, which most circuits possess to a greater or less degree, of holding a certain charge or quantity of electricity, is known as electrostatic capacity, and this, in some cases, has a marked influence on the behavior of an alternating current flowing in the circuit. The capacity of most circuits met with in practice is quite small in comparison with their resistance and inductance, consequently its effect is not usually so noticeable; however, in some cases, especially in underground cable work, these effects become important.

In case a circuit contains both resistance and capacity, the current will lead the electromotive force. The amount of lead will depend upon the relative values of the resistance and capacity. If the resistance is large compared with the capacity reactance, the angle of lead will be small, because that component of the electromotive force at right angles to the current will be small. On the other hand, if the capacity reactance is large as compared with the resistance, the current may lead the electromotive force by nearly 90 deg.

2. Whenever the number of magnetic lines of force treading through a circuit is caused to change in any way, an electromotive force is set up in the circuit, and the average electromotive force so generated depends upon the average number of lines of force changed per second, or, in other words, upon the rate at which the lines are made to change.

As an example, take a circular coil of wire. Lines of force may be made to thread through this in several ways, one way, for instance, being to bring the coil near the pole of a magnet, then move it so as to cause the number of lines passing through the coil to vary. Lines of force may also be made to thread a coil by sending a current through the coil itself.

3. Impedance is the apparent resistance in ohms of the circuit; that is, it is the quantity which, when multiplied with the total current in amperes, will give the impressed electromotive force in volts. Denoting the impedance by Z, Ohm's law as applied to alternating current circuits is $E = IZ$ in volts.

4. Inductance is the coefficient of self-induction and for any coil is obtained from the following relation:

The product of the total number of lines N threading a coil when the current is one ampere and the number of turns in the coil, divided by 100,000,000, or 10^8, gives the coefficient of self-induction. The coefficient of self-induction is usually denoted by the letter L. From the foregoing, the relation in the following formula is obtained: $(N \times T) \div 10^8 = L$, where N is the number of lines corresponding to a current of one ampere, T the number of turns, and L the coefficient of self-induction. The practical unit of self-induction is called the henry. If a coil had a coefficient of self-induction of one henry, it would mean that if the coil had one turn, one ampere would set up 100,000,000, or 10^8 lines through it as seen from the formula.

Reluctance is a property of magnetic circuits which tends to resist the passage of magnetic lines of force and may be compared to resistance in an electric circuit.

5. Retarding the rotation or movement of oscillating or rotating part or parts of instrument mechanism when the term is applied to electrical instruments. One of the most common examples of dampening is found in integrating wattmeters where a copper disk revolves between the faces of permanent magnets.

6. This is a term applied to electrical indicating instruments meaning that the needle quickly comes to rest after swinging in either direction.

V. E. JOHNSON.

Boiler Questions

WHAT CAUSES pitting in boilers?

2. What parts of a boiler are liable to pit the worst in a water-tube, vertical fire-tube and horizontal return tubular type?

3. How would you prevent pitting?

4. If a boiler has begun to pit, what would be the best method of stopping it and prolonging the life of the boiler? E. E. A.

A. It depends on conditions; shell drippage, that is, condensation from leaking header valves, will leave pit marks on the upper surfaces exposed to the drippage in all types of boilers.

Boilers left standing full of water up to the working height will corrode at and just below the water level, due to difference of temperature inside and outside.

2. Corrosion from feed water may be expected, first, at points farthest from the fire, or at points or portions that cool quickest under banked fire, or when fires are drawn. There is, however, no way of determining beforehand where any type of boiler will corrode first, or worst, as the material itself varies in composition, and one part of a plate may be attacked, and the remaining portions be unaffected.

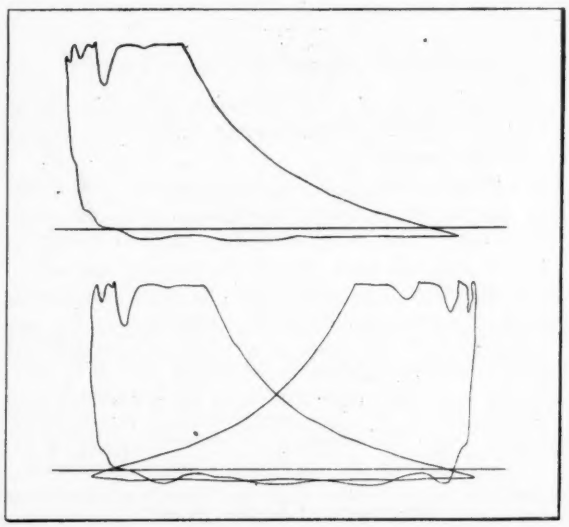
3 & 4. In cases of pitting, pits should be thoroughly cleaned out with a wire brush, and then coated with kerosene. Zinc is used with good results as a preventive, and when suspended near corroding parts, usually arrests the pitting.

In shell bottoms and mud drums, after being thoroughly cleaned and dried, the application of lime as a wash (which must be repeated at short intervals) is found efficacious. D. O. SCOTT.

Gas Compressor Performance

PLEASE CRITICIZE the attached cards taken from a 35 by 48-in. gas compressor. E. M. H.

A. Studying the gas compressor cards sent, the operation of the compressor seems to be good, but the indicator is apparently sticking, as shown by the irregularities, or steps, in the suction line. This should come down with a smooth curve, if the indicator is working freely and the compressor suction valves are not sticking.



GAS COMPRESSOR DIAGRAMS INDICATING LEAK ON DISCHARGE LINE

On the discharge line, there seems to be a peculiar drop, of greater amount than ought to be there. Some waviness of the discharge line is likely to occur from the fluttering of discharge valves, but this definite, pronounced drop would seem to indicate a leakage somewhere.

Our first thought would be a leak past the piston, due to some fall in the cylinder pressure at the point where this drop shows. This drop is particularly pronounced on the left-hand card of the diagram. On the right-hand card, there seem to be 3 such drops, which would seem to indicate some irregular action of the discharge valves, as it would not seem likely that there would be 3 points of leakage on the cylinder.

You are running, of course, with rather a light indicator spring, and it may be that this whole difficulty is in the indicator itself. Aside from these points, the diagrams seem to indicate satisfactory compressor action. A. L. R.

Determining Condition of Governor

IF YOU went into a strange engine room and the engine was not running, how would you tell whether the governor was in working order or not? J. W. R.

A. Assuming the engine to be a Corliss with a governor of the usual type, or any other kind of engine using this same governor, I would first remove the governor belt and turn the pulley by hand to see that all the revolving parts are free. Then examine the bevel gears and the keys to see that they are in working order. If the balls revolve freely when the pulley is turned, I would next lift them by hand and notice whether the cam rods levers, etc., work as they should. Examine the knockoff cams and governor dashpot. The density of the oil in dashpots differs in different engines, and I would assume that the oil in use was correct until the engine was tried. Block the governor up to about ½ its height, or to the usual running position, which will be apparent by the discoloration on the stem and guides. and slowly operate the valve gear by hand, to see if cutoff occurs on both ends as it should.

Remove the stop pin, let the governor down to the lowest point and work the valve gear by hand; this will show whether the safety cams will prevent the valves picking up when the governor is in this position. Raise the governor again, put in the stop pin and examine and replace the belt. If there was anything wrong with the governor this examination would reveal it, and the needed repairs would be obvious. This examination, however, would not determine the speed at which the engine would run. In governors of this type, the balls must revolve at such speed that the centrifugal force tending to raise the stem is equal to the force of gravity acting on the movable parts. This speed is usually stamped on some part of the governor by the builders. To find the probable speed at which the engine will run, multiply the number of revolutions per minute stamped on the governor by the diameter of the governor pulley and divide the product by the diameter of the shaft pulley. The result will be the approximate speed of the engine.

Assuming that the engine is equipped with a throttling governor of the flyball type, turn the governor pulley by hand which, if it turns freely, shows that the working parts do not bind. Then raise the balls or compress the springs to see that the valve and stem work easily through the packing; then examine and replace the belt. As these governors are equipped with an adjustable spring tension, by means of which the speed may be regulated, it would be impossible to determine beforehand what the speed of the engine would be.

On an engine having a shaft governor, disconnect the springs, see that the weights move out against the stops and that all parts work freely. Remove the valve

bonnets or steam chest cover that the working edges of the valve may be seen and, with the weights blocked out against the stops, turn the engine over slowly and watch the steam valves. If they do not open the port, it will be evident that the engine will not run away when the governor is in this position. Connect up the springs again and start the engine slowly. The speed at which it will run with the throttle open will depend on the tension of the springs, and in a strange engine can only be determined by trial or past experience with a similar engine. In starting up a strange throttling-governor engine, it would be well to let the spring tension out, and after opening the throttle gradually increase the tension until the desired speed was reached. Before starting any engine, strange or otherwise, always see that the governor bearings are well lubricated; this may prevent serious trouble from the governor sticking when the engine is running. J. C. HAWKINS.

Regulation of Compression

WHICH IS easier to regulate,—compression of a cross-compound or a tandem-compound engine? Why?

SUBSCRIBER.

A. We presume that reference is made to Corliss engines in preference to other types. In a Corliss tandem-compound engine, no matter whether the engine is equipped with double eccentrics or not, there are more connections between the eccentric and the valve gear of the rear cylinder and in taking up wear the tendency is to distort the valve setting of this cylinder much more than would be the case on the cylinder next to the frame or on either cylinder of a cross compound.

If the side rod be fixed to the wristplate, it is usually provided with right and left connections to permit accurate adjustments, but if there is a releasing hook so that the rear cylinder gear can be disengaged and operated by hand, close adjustment is not possible as the hook rod must be turned one complete revolution or not at all, and it seldom happens that the wristplate travel is equal with this kind of a device.

In such an instance, it may not be possible to secure just as good adjustments on the exhaust valves as one would wish, and one must compromise between the 2 cylinders so as to secure as good all-around operating conditions as circumstances will permit.

It sometimes happens that one cylinder of a tandem might require more advance of the eccentric than its mate, and here one must compromise again, getting some of the desired results on the valve rods if necessary; but, at best, the cards will not be ideal.

On a cross-compound engine, one has to consider but one cylinder at a time, and wristplate travel and advance of the eccentric can be worked out to one's entire satisfaction without having to keep in mind the fact that there is another cylinder that will be thrown out of harmony.

As far as valve setting is concerned, a cross compound can for the time being be considered as 2 separate simple engines, and there are no complications beyond keeping in mind what each part is for and how best to make it perform its duty.

G. H. WALLACE.

Rotor Difficulty

I HAVE a 50-hp. Westinghouse alternating-current motor, the rotor of which will not float from side to side as it should. In fact, the collar on the rotor shaft bears against the box, although it can be pushed over and away from this with little effort.

The motor is absolutely level and in line with the driven shaft. I have tried shifting the motor, but without results.

Any suggestions you could make would be appreciated. T. H. D.

A. Probably the difficulty with your motor is that the core of the rotor is not quite central with the core of the stator. The tendency is for the rotor core to run central with the stator, in a line along the axis of the motor shaft, and if it is not central, it will try to pull the shaft over so as to run central.

From what you say about the pressure required to throw the motor over, the pull is not very great, and the rotor is not far out; but apparently it is not quite where it should be on the shaft.

The remedy would be, if possible, to shift the rotor on the shaft away from the pulley. This would tend to pull the whole shaft over toward the pulley, and probably would remedy the end thrust.

You seem to have traced out all possible mechanical causes for the endwise thrust, so that we think this magnetic pull must be the trouble. A. L. R.

Location of Spools on Duplex Pumps

ARE THE spools of a duplex pump set at the center of the rod? What is the correct method of finding their proper location? J. B.

A. Some spools of a duplex pump are not necessarily set on the center of the piston rods, although in some cases there is a possibility of their being so.

Piston rods of most pumps are usually marked in some way, such as a chisel mark, to show the proper position of spools; however, the better and more positive way to reset the spool is to place your steam and water pistons on their center of travel, and then shift the spool until the rocker arm is in exact vertical position, as shown by a plumb line. Then tighten your spool in place. G. A. T.

Strength of Boiler Plate

IF I HAD a bag on a boiler, how could I find the true thickness of the metal at this point?

2. How could I determine the tensile strength of the metal at the bulge? J. M.

A. Knowing the thickness of the plate and the size and depth of the bulge, the thickness at the lowest point might be approximated, but the only sure way is to drill a hole in the lowest point of bulge and measure the plate.

2. The tensile strength will be found stamped on plates, and will be affected injuriously in proportion to the degree of heat to which plate was subjected at the time of bulging. If burned, the tensile strength will be destroyed. D. O. SCOTT.

Problems For Discussion By Readers

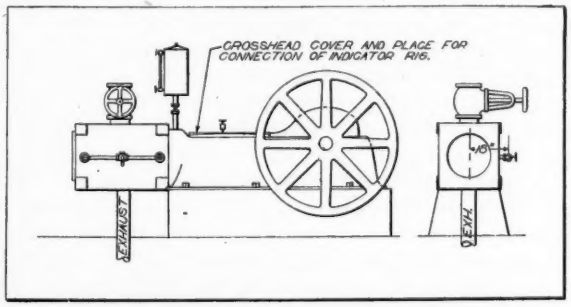
What Would You Do If You Had These Conditions To Meet?

Steam Blowers and Corrosion

I WOULD like to know the experience of engineers who have used steam blowers under the furnace grates. With certain kinds of coal, and the boiler standing unused, does the steam blower increase the external corrosion? Also, what other advantages, or disadvantages, has the steam blower when used under the grate to give forced draft? R. J.

Indicator Troubles

I AM in charge of an enclosed Ballwood engine, 15½ by 16 in., running at 215 r.p.m. and having a nonreleasing Corliss valve gear. As shown in the accompanying illustration, the cock for connecting the indicator is on the side of the cylinder, while the crosshead cover, instead of being on the side, is on top. I have made



SIDE AND END ELEVATION OF BALLWOOD ENGINE SHOWING LOCATION OF INDICATOR COCK AND CROSSHEAD COVER

several forms of appliances to attach to the crosshead and to which to fasten the indicator cord; but as yet all attempts have proven fruitless. If any of the readers can suggest a method whereby I can impart the proper motion from crosshead to indicator, I would be glad to hear from them. L. F. B.

Electric Elevator Control

WHAT ARE the reasons for and against placing automatic electric shaftway limit switches in circuit on electric elevator installations, where the machine brake is mechanical?

I would appreciate, also, suggestions and information on methods of repair and kinks in the operation and upkeep of elevators, as there is but little published on this subject, and information would be of great benefit. Can someone give full directions for replacing a cable? R. J.

Pumping Hot Water

REPLYING to the question asked by G. W. H., in the Jan. 15 issue, regarding the removal of water from a hot well, a pump will have to be used as a siphon or the ejector will not handle water at so high a temperature. The location of the pump is the thing to be considered. To reduce the lift this may be placed as low as possible, even if below the level of the water.

The expense of digging the hole and the extra pipe required will be small compared with the saving obtained by continuous service and absence of repair bills.

A motor-driven direct-connected centrifugal pump is the best for this kind of service, as there is a regular amount of water coming from the condenser all the time and the discharge of the pump can be set by throttling the discharge valve to suit conditions.

A. G. SOLOMON.

Unsuccessful Ash Ejector

I BELIEVE the trouble E. L. Hudson is having with his ash ejector is due to his method of introducing the steam.

When the steam is turned on in the arrangement shown, it creates a suction in the pipe at a and as the ashes are fed into the hopper they attain a high velocity until they reach the steam jet when they are blown out.

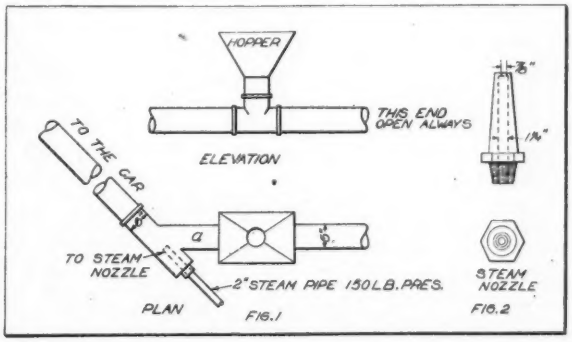


FIG. 1. PLAN AND ELEVATION OF A SUCCESSFUL ASH EJECTOR FIG. 2. ASH EJECTOR STEAM NOZZLE

All fittings should be made air-tight, so no leaks may exist, the only openings being the discharge and the end so marked in Fig. 1.

The nozzle as shown in Fig. 2, should, if possible, be made of bronze.

The writer knows of an injector of this sort which has been in successful operation the past 4 yr., and will be glad to help Mr. Hudson if he desires further information. GEO. CLEVENSTINE.

PRACTICAL
ENGINEER

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Public Welfare and Uniform Light Rates

In the matter of electric light and power rates, discussion is tending toward the comparison of the right of a central station company to discriminate between patrons in its charges for current, with the right of other classes of public utility companies to make such a distinction. Public service officials contend that the economics of the case justify the loading of interest and overhead charges for machinery to carry the peak load upon the demand which comes during the peak; also that general commercial practice justifies a lower rate for large users than for small, as is sometimes done by gas and water companies, or by railroads and street car companies for excursions. But the question of public policy and public welfare is aside from this, and the trend is to prohibit discrimination, in the interests of the public at large. The gas company has one rate to all, regardless of the time that the gas is used. The rush hour rider pays his nickel the same as the one who has half a car to himself in the early morning. Water charges are not based on the load that the system is carrying. And so on through the list.

Public welfare has seemed to be best served by uniform rates which may give to the small and infrequent patron some advantage in the ratio of expense to charge, but has distributed the burden according to the ability to bear it. And no difficulty has been found by the utility companies in arranging their accounting on this basis.

It would seem that what has been found good public policy in one line is probably good in another, and inasmuch as the central stations are as much dependent as gas or water companies on the public permission for their opportunity to do business and their protection from competition, if public welfare requires a uniform rate, such rate should and will be put in force, whether it tends to the greatest expansion of the central station or not. And if this is the logical rate requirement for electric current, it follows that overhead expense as well as operating expense must be distributed uniformly over each unit of energy or kilowatt-hour sold, in order to determine the selling price.

Unquestionably, the small user who takes most of his supply during the peak load hours will be benefited, and the large, off-the-peak power user will pay more. But the latter has a recourse in supplying his own demand, while the former has not; and scores would benefit where one would be injured. So that, if the welfare of the great number may better be served by the prescribing of the uniform rate the central station, which if a public utility, should naturally serve the public so as to be as useful as possible, should take heed of this tendency and the outcome reasonably to be expected under regulation by commissions.

Blowing Down

Considerable discussion has been carried on in recent issues of Practical Engineer by a number of readers, concerning the frequency of blowing down their boilers; it was precipitated by an engineer who stated that he never opened his blowoff valves while the boiler was under pressure. Without further consideration, such practice would naturally meet with the most severe

criticism, but a study of the operating routine of a large number of the most efficiently operated plants in the country has convinced the writer that we have been inclined to follow previous custom in regard to blowing down rather than to solve the problem for the individual plant.

The object of blowing down a boiler is to remove the sludge or precipitate before it becomes hard scale on the inside of a boiler. In ordinary boiler water the principal impurities are carbonates and sulphates of lime and magnesia; the water should be treated to convert the sulphates to carbonates, then all carbonates will be precipitated by heat in the feed water heaters, leaving the water in good condition to enter the boiler. What carbonates remain are precipitated as a sludge soon after entering the boiler, but the sulphates remain in solution until the water becomes saturated when they are precipitated. With proper precautions to purify the water in the heater, only a small amount of impurities will get into the boiler, and not until the sulphates are precipitated will hard scale be formed.

In one plant, the engineer has by means of numerous tests determined the saturation at which the sulphates are precipitated and by taking daily samples of the water in the boiler, has worked out a routine for cleaning his boilers, the intervals varying from 30 to 60 days, depending upon the rate at which they are worked, thus catching the point just before the sulphates are precipitated. The blowoff valves are never opened, except to empty the boilers, and it is reported that no hard scale is found in the tubes, but a turbine cleaner is run through the 2 bottom rows of tubes to remove soft scale; and the boilers are operated during peak loads at over 200 per cent of their rating. There are 60 B. & W. boilers in this plant, each rated at 600 hp.

No doubt the loss due to blowing down twice or even once a day amounts to a great deal, but engineers would rather stand the loss than run the risk of allowing scale to collect, through neglect to open the blowoff. The question is, however, does blowing down remove the scale-forming material from those parts of the boiler where its accumulation is dangerous or does frequent blowing down reduce the percentage of sulphates in solution to such an extent that they will not be precipitated?

News Notes

Boston Association No. 12 of the Stationary Engineers, held an open meeting on Feb. 1, at Franklin Union Hall, presided over by David MacGibbon. Music and lighter entertainment were enjoyed in addition to the speeches as follows: Peter H. Bullock, Chief Engineer, Concord Reformatory, "Vaporings of a Veteran"; Geo. A. Luck, Chief Examiner of Engineers, Chairman Board of Boiler Rules; Theodore N. Kelsey, Chief Engineer, Lawrence Mfg. Co., Lowell; Scribner K. Page, President Power League of New England; Edward H. Kearney, Past National President N.A.S.E.; Thomas A. Ray, President New England States Association of Stationary Engineers; Wm. K. Campbell, President New England Association of Commercial Engineers.

The Advertising Association of Chicago recently appointed a committee composed of Messrs. R. J. Virtue, of Peoples Gas Bldg.; C. L. Bates, of the Railway Review, and Anderson Pace, Industrial Commissioner of the Chicago Association of Commerce, to establish a clearing house of information on industrial, marketing and advertising subjects. Plans have been made to extend this service to the advertisers and subscribers in technical journals, and the bureau will be glad to answer any calls for information which cannot be easily secured through ordinary channels. The desire of the committee is particularly to help, 1, the manufacturer who wishes to branch out into new lines; 2, the manufacturer with idle equipment who wants to find something to keep his plant busy; 3, the man who wants industrial, advertising or marketing information of any kind which is hard to find. The services of this bureau are offered free of charge to subscribers and advertisers of Practical Engineer who desire information along the lines mentioned, as the bureau seeks solely to act as a clearing house for trade associations, individual manufacturers and others who find difficulty in doing research work for themselves. Inquiries may be sent to Practical Engineer, with the assurance that they will be promptly forwarded to the Information Bureau.

U. S. Civil Service Commission announces an examination, March 2, 1915, for consulting mining engineer, to fill vacancies in the Bureau of Mines, Dept. of the Interior, for service in the field, at a salary ranging from $3000 to $3600, or at the rate of $10 a day when actually employed. Duties will be to make examinations in different parts of the United States, including Alaska, concerning gravel gold mining operations, including dredge mining, hydraulic mining, and drift mining; and to prepare reports for the Bureau of Mines on conditions and progress in these branches of the mining industry. The following subjects will have the relative weights indicated: Education and experience, 65; publications and reports, 35. As prerequisites for consideration, applicants must have had professional experience as mining engineer in connection with gold mining operations, extending over a period of not less than 10 yr., of which not less than 5 yr. must have been given to professional work in connection with gravel gold mining operations. This must have included operations in connection with dredge mining, hydraulic mining, and drift mining. Apply for Forms 304 and 2095, giving the title, Consulting Mining Engineer, Male.

The Terry Steam Turbine Co., Hartford, Conn., announces the appointment of Earl F. Scott, with offices at 702 Candler Bldg., Atlanta, Ga., as the company's representative for the State of Georgia. The Pittsburgh office, in charge of H. A. Rapelye, is now located at 1624 Oliver Bldg.

At the meeting on Jan. 7, the following officers of the Chicago Electric Club were chosen: President, W. R. Pinckard, Chicago Manager of the Detail & Supply Dept., Westinghouse Electric & Mfg. Co.; Vice President, W. D. Ray, with the Northern Indiana Gas & Electric Co.; Secretary, O. H. Caldwell, Associate Editor of Electrical World; Treasurer, A. B. Hatch, Secretary of the Pelouze Mfg. Co.; Board of Managers, A. L. Eustice, Ray Palmer, W. G. E. Pierce, R. I. Phillips, and P. B. Woodworth.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Nash Hydro-Turbine Vacuum Pump

FOR use in connection with vacuum heating systems, vacuum filtration, or wherever air containing a large percentage of liquid has to be handled, a novel vacuum pump has been put on the market by the Nash Engineering Co., of South Norwalk, Conn. Figure 1 shows clearly the various parts. A Nash hydro-turbine and Gould centrifugal are mounted in line on a cast-iron base. A separator is connected at the bottom to the centrifugal and near the top to the Nash pump. A check valve is placed on the outlet of the centrifugal.

The action of the outfit is as follows: As soon as the shaft is rotated the Nash hydro-turbine produces a vacuum in the system, which draws water and air into the separator. The water falls to the bottom of the separator and is discharged by the centrifugal. The air is drawn from the top of the separator by the Nash pump.

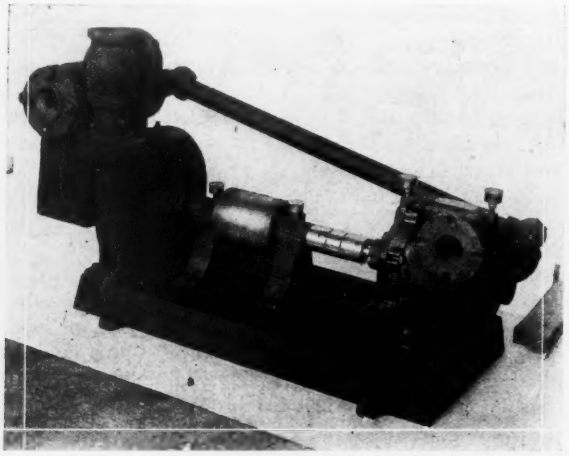


FIG. 1. COMPLETE VACUUM PUMPING UNIT AS USED IN HEATING SYSTEMS

As the amount of water handled varies, the centrifugal is made large enough to take care of the maximum quantity. When less water than this comes along the centrifugal continues to pump water until the separator is empty. The centrifugal then ceases to deliver water, but the check valve on the outlet prevents the vacuum from being broken.

As soon as the water has accumulated in the separator sufficiently to submerge the inlet, the centrifugal takes hold once more and pumps the water out.

Advantages of this simple combination are at once apparent. The water and air are handled separately in pumps specially designed for the purpose, the air in the air pump and the water in a water pump, which means greatly increased efficiency. The water may be delivered efficiently against a head without putting any back pressure against the air pump, which means a big saving in power, as the air pump is of relatively large volume as compared with the water pump. It is possible to handle water containing dirt and abrasive material, as this all passes through the centrifugal, which is adapted for this service, and furthermore, may be replaced at small expense if it is finally worn out.

An examination of Fig. 2, showing the interior of the Nash pump, shows the simple and efficient principle upon which it works, and why it is specially adapted to the service described above.

Water follows the case, due to centrifugal force. Twice in a revolution the water recedes from the rotor, thereby leaving spaces between the blades, into which the air is drawn through the inlet ports. The water then surges back into the rotor compressing and delivering the air through the outlet ports. The water seal

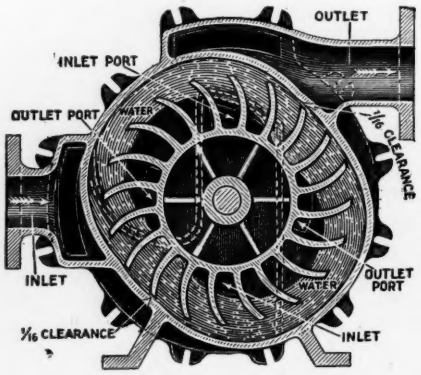


FIG. 2. SECTIONAL VIEW OF THE NASH HYDRO-TURBINE

prevents leakage. The water is used continuously. The suction is uniform. The pressure on the shaft due to compression is balanced. There are no valves or loose-moving parts. The rotor is the only moving element and is fitted with ample clearance.

The large volume of air handled by the Nash pump keeps the centrifugal primed and free from air, which means that it works at its highest efficiency. The large volumetric capacity also makes it possible to produce a vacuum when handling extremely hot water. Under these conditions the action of the pump is as follows:

Vacuum rises until the point is reached where the water becomes steam at the existing temperature. The Nash pump takes the steam away as fast as formed.

The steam is drawn into the pump under a vacuum and is compressed by the pump and delivered at atmospheric pressure. As the steam is compressed some of it condenses and is delivered as water.

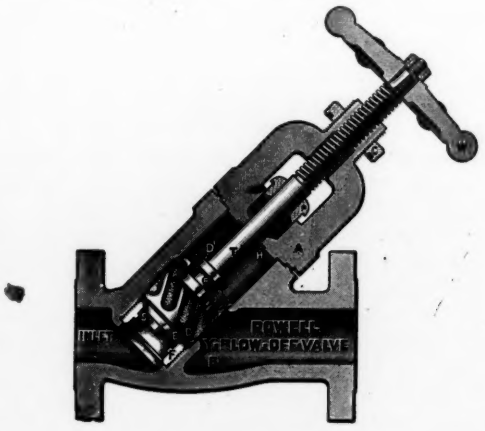
The reliability of this outfit is one of its strongest points, as both pumps have only one moving part, running with a clearance. The machine shown in the cut (1) is arranged for belt drive. It can also be furnished for direct connection.

The primary object of a vacuum pump in a heating system is to remove rapidly the air, which is very detrimental to the efficiency of the system. The pump should do this without the necessity of introducing cooling water, with consequent loss of heat. This is very effectively accomplished by the Nash hydro-turbine.

Steam Valves for High Working Pressure

SEVERE demands made upon blowoff valves frequently cause them to break down or leak badly after a few months, hence owners and operators of steam plants will be interested in the announcement that The Wm. Powell Co., Cincinnati, O., after a long series of experiments, has produced an exceedingly durable valve, known as the Powell Y blowoff valve.

The illustration given herewith shows clearly the improvements that have been made.



POWELL STRAIGHTWAY Y BLOWOFF VALVE

The yoke top A is secured to the body B by studs. Packing is secured and regulated by the pusher gland P, which is operated by the outside screw nut C above the bridge of the yoke, a construction which enables the engineer to adjust the pressure at any time with an ordinary monkey-wrench, and eliminates the danger of accident when the packing has to be renewed. Faces D and H, fitting tight, permit the valve to be repacked under pressure when wide open. The plunger D is of brass, milled to receive the collar on stem T, and has spiral grooves cast on the outer face, which receive the steam pressure as the valve is opened and cause it to revolve as it nears the seat when closing, keeping both disc and seat clean of scale and sediment. The seat ring F has been lowered to protect it from the cutting effect of the rushing steam as the valve is opened. To the plunger is attached the Powellium white bronze renewable, reversible and regrinding disc E, secured to stem by disc nut S, disc face and seat-bearing being at such an angle that sediment or scale does not lodge between them, either while blowing off or closing down the disc.

To regrind this valve, a wire pin or nail is inserted through the hole R in the plunger; locking the disc. Then rotate back and forth with a little fine brick dust or sand on the bearing.

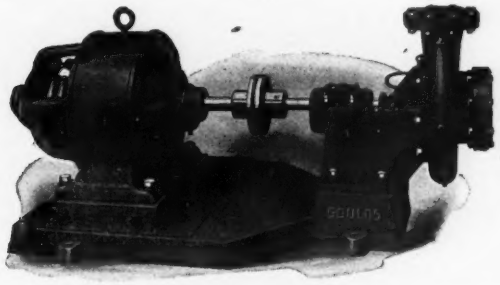
The seat ring F is of Powellium white steam bronze and has 2 faces so that when one is worn it may be readily removed and reversed by means of the lugs cast in the throat of the ring, this construction and the special metal for disc and seat insuring long life, and the withstanding of 2000 deg. F. The entire valve is very heavy, well proportioned and of excellent workmanship. These valves are made in 2, 2½ and 3 in. sizes, with screwed or flanged ends. Each valve is tested to 250 lb. hydraulic pressure and is guaranteed to stand the severe service to which it may be subjected.

New Goulds Centrifugal Pump

GOULDS horizontal single-stage single-suction enclosed-impeller centrifugal pump has been developed to meet the demand for high efficiency in a moderate priced machine, and is designed for direct connection to an electric motor, although obtainable for belt drive.

The cast-iron casing is of the volute type supported on a bedplate so that it may be swiveled in any one of 8 different positions, and proportioned to convert the energy of velocity of the water, leaving the propeller into pressure with a minimum of loss due to shock or eddies.

The casing is flanged and bolted to the support head and located in alinement with the support head bearings by a male and female lock.



GOULDS HORIZONTAL SINGLE-STAGE SINGLE-SUCTION ENCLOSED IMPELLER CENTRIFUGAL PUMP NO. 5

All main bearings are of the ring oiling type, the larger size pumps having 2 rings.

The impeller is made of close-grained cast iron and is pressed upon the shaft and held in place by a carefully fitted pin. Any end thrust occurring in operation is taken up by shaft collars bearing upon babbited surfaces which are positively lubricated. These collars also serve to space the impeller properly in the casing.

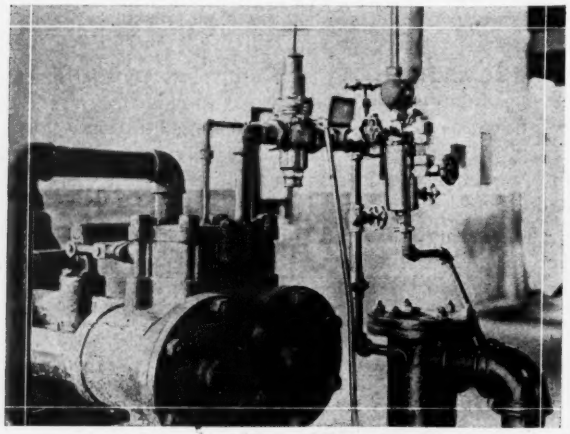
The support head casting forms the stuffing box cover of the casing, contains 2 bearings and carries the complete pump when assembled. The outboard end is a horizontally-split, babbited, ring-oiling bearing provided with oil stand and reservoir, and the bearing cap held in alinement with the bearing by means of taper dowel pins and studs by lock nuts.

The stuffing box is fitted with brass water seal ring, and its end next to the impeller is lined with a brass bushing forming a second water lubricated bearing for the shaft close to the impeller. Both bearings are cast integral with the support head and can, therefore, never be thrown out of alinement.

Reducing Valve for Fuel Oil Supply

C. COOPER, engineer of the station, sent to the Mason Regulator Co. a description of his use of a reducing valve which was awarded 4th prize in the contest.

"The ¾-in. Mason Reducing Valve shown is in the steam turbine generating plant of the Portland Ry., Light & Power Co. of Portland, Oregon, known as Sta. E, and having a capacity of 10,500 kw. This valve is connected to a 6 by 4 by 6-in. duplex steam pump, supplying fuel oil to 40 oil burners and maintaining practically a constant pressure from no burner to maximum.



MASON REDUCING VALVE IN PLANT OF PORTLAND RY., LIGHT & POWER CO.

"The installation is in duplicate and the pumps were received from the manufacturers with the regulators connected from the discharge in the usual way, but on account of the drippings of fuel oil and its carbonizing in the regulators (using 175 deg. F. superheat) we changed the connection to the steam chest covers as shown. There they have given better regulation and have never cost one cent for repairs since they were changed, which was in the spring of 1905."

IT IS well to make a good start, but one should always keep in mind what he wishes the finished job to be; it may save the necessity of side steps and avoid errors which cannot be corrected.

G. E. Co. Exhibit at Panama Exposition

THE exhibit of the General Electric Co. in the Transportation Building at the Panama-Pacific International Exposition will comprise electric locomotives for various classes of service including steam railroad electrification, railway motors and all kinds of apparatus and accessories for electric railways, signal accessory electric devices, electric apparatus and equipment for railway shops, electric illumination for cars and shops, etc.

One interesting exhibit will be electric locomotives coupled together ready for shipment across the continent.

A 60-ton electric locomotive built for interurban freight and passenger service will also be on exhibit. This machine is designed for both 600 and 1200 v. operation. The cab is of all-steel construction and is divided into 3 sections, the central operating cab containing the controller and other apparatus that should be within immediate reach of the engineer, and the 2 end steeple back cabs containing the auxiliary electrical apparatus. The motor equipment consists of 4 GE-251 commutating-pole motors, one mounted on each axle and arranged for forced ventilation from a blower in the cab.

There will also be a 16-ton electric locomotive of similar design with steeple-back end cabs for industrial freight and switching service, equipped with 2 commutating-pole ventilated motors. Two types of electric mine locomotives will be shown, 1 a 20-ton trolley type equipped with 3 motors and the other is a 6-ton combination trolley and storage battery locomotive equipped with 2 motors, all of the commutating pole type.

A storage battery platform truck and also a battery truck crane for moving freight in warehouses, factories and on docks will be exhibited. There will be a portable air compressor set for use around factories, the compressor being fitted with a glass cover and the interior illuminated to show the operation.

One of the most interesting features of the exhibit will be the 2 single end type MK control equipments, each mounted on a separate rack in the usual manner of installing for service. Another rack will contain a complete Type M multiple unit control designed for 3 speed operation in city service. The controller exhibit includes the standard K-35, K-36, K-51 and K-201 types, the last named designed for 3 running positions. A complete assortment of line material will be grouped on a large frame, many of the devices in the same manner as installed in actual service.

A large number of separate valves, contractors, governors, fuse boxes, rheostats, switches, lightning arresters and other devices entering into car equipment, will form part of the exhibit. Forged steel, treated gears and also cast steel split and solid gears and pressed steel gear cases for city, suburban and interurban service will be shown, as well as several grades of forged steel treated pinions and pinion pullers. A display of railway and automobile lamps will also be included, while shadow boxes and photometric curves will demonstrate the relative value of these units. There will likewise be a com-

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PRACTICAL ENGINEER

HEATING SCHEDULE

Date - JAN. 7, 1914 — Job No. 15 — Sheet No. 1
Building - J. D. BROWN - RESIDENCE — Location - MINNEAPOLIS, MINN.
Based on outside temperature of - 30° — FIRST FLOOR — Calculated by - C. F. TWEED
Required room temperature - 70° — Checked by - C. F. TWEED
No. of air changes allowed - ¾ in living rooms, 2 in hall — Ceiling height - 12'-0"
Construction of walls - 12" brick, furring space, ½ plaster — Window height - Varies
Construction of windows - Double — Stool height - Varies
Construction of roof - — Method of heating - Direct Hot Water
B.T.U. per sq.ft. radiation ($K_r(T_3 - T_1)$) = 145 — Method of ventilating
Total sq.ft. radiation, this floor = 75.3⅓ — No. of radiators
Equivalent sq.ft. radiation 145 B.T.U. per sq.ft. = 750

Room No.	Name of Room	Dimensions of Room	Volume Cu.Ft.	Wall Sq.Ft.	Glass Sq.Ft.	Roof Sq.Ft.	Factors	Radiation Sums		Exp. + Factor	Corrected Size	No. of Rad.	Standard Size	Final Size	Remarks
100	Living Room	20×31×12	7500	640	212		.0114 .138 .346	86 88 73	247	N.W.S. 1.13	290	4	2c-32" 1.00	73⅓ ea	
101	Hall	18×15×12	3240	111	105		.0304 .138 .346	98 15 35	148	S 1.00	148	2	2c-38" 1.00	76 ea	Door + to glass
102	Toilet	6½×5½×12	462	51	13		.0114 .138 .346	4.1 7 5	16	S 1.00	16	1	1c-26" 0.86	14	On brackets
103	Dining Room	13×19½×12	3040	162	128		.0114 .138 .346	35 22 44	101	S.E. 1.04	105	2	13 R.W. 1.10	57 ea	High Legs
104	Pantry	9½×11×12	1250	188	58		.0114 .138 .346	14 26 20	60	N.E. 1.17	70	1	2c-45" 1.00	72	
105	Kitchen	24×15½×12	4460	190	98		.0114 .138 .346	31 26 20	97	N 1.25	121	2	2c-22" 0.90	36 72	
	Totals								669	1.12	750	12	1.00	753⅓	

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PRACTICAL ENGINEER

TABLE I. CONSTANTS FOR STEAM HEATING SYSTEMS

Steam Heating

Value of K_{Rs} from Formula.

$$K_{Rs} = \frac{K(T_1 - T_2)}{K_r(T_3 - T_1)} \times 1$$

Basis $T_1 = 70°$ $T_3 = 220°$ $K_r = 1.63$ B.T.U.

	"K"	Value of K_{Rs}				
		60°	70°	80°	90°	100°
(T_1-T_2) Temperature rise		.135	.137	.160	.202	.225
Walls.						
4" Brick, no plaster.	.55	.096	.112	.127	.143	.159
8"	.39	.076	.089	.101	.114	.127
12"	.31	.062	.072	.082	.092	.102
16"	.25	.052	.060	.069	.077	.086
20"	.21	.044	.052	.059	.066	.074
24"	.18	.039	.046	.052	.059	.066
28"	.16	.032	.037	.043	.046	.053
32"	.13	.030	.035	.039	.044	.049
4" Brick, furring + plaster.	.28	.069	.080	.092	.103	.114
8"	.24	.059	.069	.079	.088	.098
12"	.20	.049	.057	.066	.074	.082
16"	.18	.044	.052	.059	.066	.074
20"	.16	.039	.046	.052	.059	.066
24"	.14	.034	.040	.046	.052	.057
28"	.13	.032	.037	.043	.046	.053
32"	.12	.030	.035	.039	.044	.049
12" Sandstone furring + plaster.	.28	.069	.080	.092	.103	.114
18"	.23	.062	.072	.082	.092	.102
24"	.23	.057	.066	.074	.083	.094
30"	.21	.052	.060	.069	.077	.086
36"	.19	.047	.055	.062	.070	.078
48"	.17	.042	.049	.056	.063	.070
2×4 Clapboards, lath + plaster.	.25	.062	.072	.082	.092	.102
2×4 " lath, plaster + fillings.	.10	.025	.029	.033	.037	.041
Partitions.						
Studs, plaster one side	.49	.120	.140	.160	.180	.200
" " both "	.34	.083	.097	.111	.125	.139
Expanded metal-asbestos fill.	.21	.052	.060	.069	.077	.086
Fireproof tile plaster both sides	.30	.074	.086	.098	.110	.123
Solid plaster - 2"	.60	.147	.172	.196	.220	.245
" " 3"	.50	.123	.143	.164	.184	.205
Doors.						
1" Solid wood	.48	.118	.137	.157	.176	.196
1½" " "	.43	.105	.123	.140	.158	.176
2" " "	.31	.076	.089	.101	.114	.127

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PRACTICAL ENGINEER

TABLE II. CONSTANTS FOR HOT WATER HEATING SYSTEMS

Hot Water Heating

Value of K_{Rw} from Formula

$$K_{Rw} = \frac{K(T_1 - T_2)}{K_r(T_3 - T_1)} \times 1$$

Basis $T_1 = 70°$ $T_3 = 170°$ $K_r = 1.45$ B.T.U.

	"K"	Value of K_{Rw}				
		60°	70°	80°	90°	100°
(T_1-T_2) Temperature rise		.228	.266	.304	.342	.380
Walls.						
4" Brick, no plaster.	.55	.162	.188	.215	.242	.269
8"	.39	.129	.150	.171	.193	.214
12"	.31	.104	.121	.138	.155	.173
16"	.25	.087	.102	.116	.131	.145
20"	.21	.075	.087	.100	.112	.124
24"	.18	.067	.078	.088	.100	.110
28"	.16	.058	.068	.078	.087	.097
32"	.13	.052	.058	.067	.073	.083
4" Brick, furring + plaster.	.28	.116	.135	.155	.174	.193
8"	.24	.099	.116	.133	.149	.166
12"	.20	.083	.097	.111	.125	.138
16"	.18	.075	.087	.100	.112	.124
20"	.16	.067	.078	.088	.100	.110
24"	.14	.058	.068	.078	.087	.097
28"	.13	.054	.063	.072	.081	.090
32"	.12	.050	.058	.067	.073	.083
12" Sandstone furring + plaster.	.28	.116	.135	.155	.174	.193
18"	.23	.104	.121	.138	.155	.173
24"	.23	.095	.111	.127	.143	.159
30"	.21	.087	.102	.116	.131	.145
36"	.19	.079	.092	.105	.118	.131
48"	.17	.071	.083	.094	.106	.118
2×4 Clapboards, lath + plaster.	.25	.104	.121	.138	.155	.173
2×4 " lath, plaster + fillings.	.10	.042	.049	.055	.062	.069
Partitions.						
Studs, plaster one side	.49	.203	.237	.271	.304	.338
" " both "	.34	.141	.166	.188	.212	.235
Expanded metal-asbestos fill.	.21	.087	.102	.116	.131	.145
Fireproof tile plaster both sides.	.30	.125	.145	.166	.187	.208
Solid plaster 2"	.60	.248	.290	.331	.372	.414
" " 3"	.50	.208	.242	.277	.311	.346
Doors.						
1" Solid wood	.48	.199	.232	.266	.298	.331
1½" " "	.43	.178	.207	.237	.266	.296
2" " "	.31	.129	.150	.171	.193	.214

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Directions for Estimating Heating Requirements

Fill out as completely as possible data at top of "Heating Schedule" sheet. Number the rooms consecutively and record in first column; opposite the numbers write the names of the rooms in second column. In the third column put the dimensions of the rooms—length width and height. Columns 4, 5, 6 and 7 are respectively for the volume in cubic feet, outside wall surface in square feet, glass surface in square feet, and exposed roof surface in square feet. The multiplying factors are placed in the eighth column and are secured from Tables I or II, according to whether steam or hot water is used. In the ninth column place the radiator surface necessary to care for the different heat requirements of the room found by multiplying the value in one of the preceding columns by the factor opposite it in column 8. In column 10 is the total heating surface for the various rooms; this surface must be corrected for exposure, which is noted and factor, found in Table III, placed in column 11, and the corrected surface is given in column 12, found by multiplying the values in column 10 by the factors opposite in column 11. In the next column is the number of radiators to each room, followed, in column 14, by the standard size radiator and correction factor given in Table V. The final size of each radiator is given in column 15, and in the last column is space for remarks.—Copyrighted by Carleton F. Tweed.

TABLE III. PERCENTAGE ALLOWED FOR EXPOSURE

Wall Exposure	Multiplier	Wall Exposure	Multiplier
North	1.25	Northwest	1.19
West	1.13	Southwest	1.08
East	1.08	Northeast	1.16
South	1.00	Southeast	1.04

TABLE IV. HEAT RADIATING FACTORS (VALUES FOR Kr.)

t. Rad. -t. Room	165	160	155	150	145	140	130	120	110	100	90
Kr.	1.70	1.68	1.65	1.63	1.60	1.58	1.55	1.53	1.50	1.45	1.37
Kr.x(t3-t1)	280	268	256	245	232	222	202	184	165	145	123

Kr. = Heat transmission from radiator to air per degree temperature difference, per square foot, per hour.
t3 = Temperature of rad. t1 = Temperature of room.

TABLE V. CORRECTION FACTORS FOR HEAT RADIATING SURFACES

Percentage Correction Factors For Heat Transmission Coefficient Kr Radiator 2 Column - 32 in. high = 100%					
Type of Heating Surface		Kr for Steam Rad.-220° Room-70°	Correction Multiply by	Kr for Hot Water Rad.-170° Room-70°	
Standard Pipe	Concrete Floor	To 1"		2.66	0.62	2.36	
Single Pipe		1" to 3½"		2.36	0.67	2.19	
Horiz. or Vert.		over 3½"		2.35	0.70	2.09	
Pipe Coils 3'-0" High		To 1"		2.36	0.64	2.28	
		over 1"		2.25	0.73	1.96	
Pipe Coils more than 3'-0" high		To 1"		2.25	0.73	1.96	
		over 1"		1.95	0.84	1.73	
Cast Iron or Steel Radiators - Reg. Centers							
32" high		1 Col.		1.74	0.94	1.55	
38" "		2 "		1.63	1.00	1.45	
45" "		3 "		1.40	1.17	1.25	
		4 "		1.35	1.21	1.18	
20" high		1 Col.		1.91	0.86	1.70	
23" "		2 "		1.81	0.90	1.61	
26" "		3 "		1.59	1.02	1.42	
		4 "		1.48	1.10	1.32	
Window Rad. 13"-18" high Hi Legs		6 "		1.48	1.10	1.32	
C.I. Wall Radiators		3" Sec. Horiz. Tapp.		1.92	0.85	1.71	
		3" Sec. Horiz. Tapp.		2.10	0.78	1.67	
		7" Sec. Vert. Tapp.		1.70	0.96	1.51	
		7" Sec. Vert. Tapped		1.90	0.86	1.69	

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TABLE II. (CONTINUED) CONSTANTS FOR HOT WATER HEATING SYSTEMS

	"K"	Value of KRw				
(Ti-Ta) Temperature rise.		60°	70°	80°	90°	100°
Roofs.						
Slate on 1" boards.	.43	.178	.207	.237	.266	.296
Composition.	.30	.124	.145	.166	.186	.207
Reinforced concrete.	.43	.178	.207	.237	.266	.296
Sheet iron.	1.2	.497	.580	.662	.745	.828
Corrugated iron.	1.5	.621	.714	.828	.932	1.03
Tiling 1" thick.	.80	.331	.386	.441	.496	.551
4" Concrete Cinder fill.	.60	.248	.290	.331	.372	.414
6" concrete " "	.50	.207	.242	.276	.311	.346
Windows.						
Single windows	1.05	.435	.507	.580	.652	.724
" " wire glass.	1.35	.559	.652	.744	.838	.931
Double "	.50	.207	.242	.276	.311	.346
Single skylight.	1.10	.455	.532	.607	.683	.760
Double "	.60	.248	.290	.331	.372	.414
Air.						
½ cu. ft. of air		.0042	.0050	.0058	.0067	.0076
¾ " " " "		.0063	.0075	.0087	.0100	.0114
1 " " " "		.0083	.0099	.0116	.0133	.0152
1¼ " " " "		.0104	.0124	.0145	.0167	.0190
1½ " " " "		.0125	.0149	.0174	.0200	.0228
2 " " " "		.0166	.0199	.0233	.0268	.0304
2½ " " " "		.0208	.0248	.0290	.0334	.0379
3 " " " "		.0250	.0298	.0348	.0400	.0455
(Ti-Ta) Temperature rise.		30°	40°	50°	60°	70°
Floors.						
Cement or tile on ground.	.30	.062	.083	.104	.124	.145
" " " wood over.	.10	.021	.028	.034	.041	.048
Dirt floor.	.20	.041	.055	.069	.083	.097
Fireproof construction.	.10	.021	.028	.034	.041	.048
Cement on brick arch.	.20	.041	.055	.069	.083	.097
¾" wood-plaster below.	.20	.041	.055	.069	.083	.097
¾" " no plaster.	.40	.083	.110	.138	.166	.193
¾" double wood plaster below.	.10	.021	.028	.034	.041	.048
¾" " " no plaster.	.27	.056	.075	.093	.112	.131
Ceilings.						
Fireproof-floor above.	.15	.031	.041	.052	.062	.072
" no floor.	.30	.104	.138	.172	.205	.242
Cement or tile floor above.	.10	.021	.028	.034	.041	.048
" " " no floor.	.40	.083	.110	.138	.166	.193
Steel-floor above.	.14	.072	.097	.121	.145	.169
Lath + plaster-floor above.	.23	.052	.069	.086	.104	.121
" " no floor.	.50	.104	.138	.172	.205	.242

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TABLE I. (CONTINUED) CONSTANTS FOR STEAM HEATING SYSTEMS

	"K"	Value of KRs.				
(Ti-Ta) Temperature rise.		60°	70°	80°	90°	100°
Roofs.						
Slate on 1" boards.	.43	.105	.123	.140	.158	.176
Composition.	.30	.074	.086	.098	.110	.122
Reinforced concrete.	.43	.105	.123	.140	.158	.176
Sheet iron.	1.2	.294	.343	.391	.440	.490
Corrugated iron.	1.5	.367	.428	.490	.550	.612
Tiling 1" thick	.80	.196	.229	.261	.294	.326
4" Concrete-cinder fill.	.60	.147	.172	.196	.220	.245
6" " " "	.50	.123	.143	.163	.184	.204
Windows.						
Single window.	.105	.257	.300	.343	.386	.428
" " wire glass.	.135	.331	.386	.441	.496	.551
Double "	.50	.123	.143	.163	.184	.204
Single skylight.	.110	.270	.314	.360	.404	.450
Double. "	.60	.147	.172	.196	.220	.245
Air.						
½ Cu. ft. of air.		.0025	.0029	.0034	.0039	.0045
¾ " " " "		.0037	.0044	.0052	.0059	.0067
1 " " " "		.0049	.0059	.0069	.0079	.0090
1¼ " " " "		.0062	.0073	.0086	.0099	.0112
1½ " " " "		.0074	.0088	.0103	.0119	.0135
2 " " " "		.0098	.0117	.0138	.0158	.0180
2½ " " " "		.0123	.0147	.0172	.0198	.0224
3 " " " "		.0148	.0176	.0206	.0237	.0270
(Ti-Ta) Temperature rise.		30°	40°	50°	60°	70°
Floors.						
Cement or tile on ground.	.30	.037	.049	.061	.074	.086
" " " wood over.	.10	.012	.016	.020	.025	.029
Dirt floor.	.20	.025	.033	.041	.049	.057
Fireproof construction.	.10	.012	.016	.020	.025	.029
Cement on brick arch.	.20	.025	.033	.041	.049	.057
¾" Wood-plaster below	.20	.025	.033	.041	.049	.057
" " no plaster.	.40	.049	.065	.082	.098	.114
¾" double wood-plaster below.	.10	.012	.016	.020	.025	.029
" " " no plaster.	.27	.033	.044	.055	.066	.077
Ceilings.						
Fireproof-floor above.	.15	.018	.025	.031	.037	.043
" no floor.	.30	.061	.082	.102	.123	.143
Cement or tile-floor above.	.10	.012	.016	.020	.025	.029
" " " no floor.	.40	.049	.065	.082	.098	.114
Steel-floor above.	.14	.043	.057	.071	.086	.100
Lath + plaster-floor above.	.23	.031	.041	.051	.062	.072
" " no floor.	.50	.061	.082	.102	.123	.153

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plete line of both incandescent and luminous arc head lamps with semaphore lenses and parabolic reflectors.

The line of signal accessories will include transformers, vacuum and multi-gap lightning arresters, motor-generator set, switchboard, instruments, etc. Other interesting apparatus of various kinds will be a standard mercury arc rectifier for battery charging, an electric arc welding outfit, car fans, a new high frequency oscillator, a full line of insulators, a new multi-recorder for attaching to switchboards to keep automatically a record of the time of the manipulation of the various switches, an 18-in. searchlight projector, complete line of circuit breakers, etc.

An attractive and instructive feature of the exhibit will be a stereomotograph, which will project automatically on a large ground-glass screen several hundred illustrations showing the range of modern traction developments.

Catalog Notes

CENTRIFUGAL PUMPS is the title of a 64-page bulletin just issued, giving details and data on various turbo-pump applications. The principles of operation and construction of the centrifugal pump are clearly explained, as are the details of the steam turbines which have been used during the past 10 yr. for driving them. Because of the wide latitude of speed possible with the turbine, the unit occupies a much smaller space than would be required for a pump performing the same duty but driven by a reciprocating engine, the range of conditions varying from large volumes of water pumped against low heads, such as circulating water for condensers or for irrigation, up to high head work, such as boiler feeding or fire service.

Anyone interested in pumping problems may secure a copy by writing to The Terry Steam Turbine Co., Windsor St. at Windsor Ave., Hartford, Conn.

THE GENERAL ELECTRIC CO. has just issued Bulletins No. 44,403 and 44,405, describing that company's ventilated commutating-pole railway motors for 600 and 600/1200 v. service.

Bulletin 44,403 is devoted to the GE-222-G railway motor which has a rated output of 140 hp. at 600 v., and, having modified windings, can be supplied for operation with 2 in series on 1200 v., at which voltage the rating is 130 hp.

Bulletin 44,405 describes the GE-233-A motor for operating 2 in series on 1200 v. This has an hourly rating of 75 hp.

Both motors are described in considerable detail, and each bulletin contains characteristic curves of the motors.

A BOOKLET descriptive of the manufacture of "Youngstown" steel and "Youngstown Star Brand" wrought iron pipe presents a series of views outlining the evolution of "Youngstown" pipe. The manufacturer is The Youngstown Sheet & Tube Co., Youngstown, O.

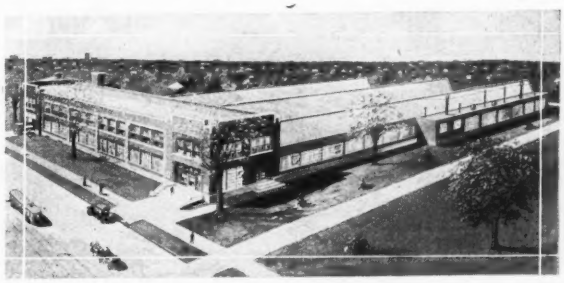
DEFENDER REGULATOR CO., 6th and Locust Sts., St. Louis, recently issued Bulletin A, describing and illustrating Defender gas collectors, Orsat apparatus and differential draft gages.

A NEW FOLDER from The Ohio Brass Co., Mansfield, O., illustrates some styles of Ohio brass valves.

BOILER CLEANING LOGIC, as applied to the external surfaces of steam boilers, is the subject of a pamphlet relating to the Bayer soot blower system of Bayer Steam Soot Blower Co., St. Louis, Mo.

Trade Notes

THE TOLEDO PIPE THREADING Machine Co. of Toledo, O., has just completed and is occupying a beautiful new building with frontage of 120 ft. on Summit St. overlooking the Maumee River. In the 2-story front structure, which is of brick, steel and con-



crete, are the offices, stock room and a large welfare room for employes. Running back from this are the 1-story manufacturing wings of glass, steel and concrete with saw-tooth roofs, giving splendid lighting and exemplary ventilation.

With this new modern plant, the company expects to better the quality, if that is possible, of its product, the Toledo Pipe Threading devices, to develop new ideas and to continue to supply efficient mechanisms for the cutting and threading of pipe.

THE KENNEDY-STROH CORPORATION of Pittsburgh, with a capitalization of approximately $2,500,000, has taken over all the rights, processes and factories of the Kennedy Manufacturing & Engineering Co. of New York, The Stroh Steel Hardening Process Co., the Lawrence Steel Casting Co. and the Best Manufacturing Co. of Pittsburgh, Pa., and will operate as a main plant the factory at Oakmont, formerly operated by the Best Mfg. Co., also the old Lawrence Steel Plant at 32nd St. and A. V. R. R., Pittsburgh, as the Lawrence Dept.

The Kennedy line of mining, crushing, cement making and conveying machinery is one of the most extensive of American manufacture. The Stroh steel hardening process is a method of casting 2 kinds of steel in one solid casting in such a manner that the hard alloy comes on, and only on, the parts which are subjected to wear. The Lawrence Steel Casting Co., which was established in 1883, is one of the first concerns of its kind in the Pittsburgh District. The Best Mfg. Co. has been manufacturing a superior line of power piping, flanges, fittings and valves for 30 yr. and has some of the largest installations in service in the United States.

W. H. Schoen, formerly connected with the Schoen Pressed Steel Co., now the Pressed Steel Car Co., is President of the new corporation and will be the active business head. J. E. Kennedy, who will be Vice Presi-

dent and Chief Engineer, has been recognized as the leading designer of mining, and other machinery which bears his name, for more than 20 yr. J. L. Kendall, of the Kendall Lumber Co. and allied interests, one of the most prominent financiers of Pittsburgh, is Treasurer. J. D. Hiles, who has been connected with the Best Mfg. Co. for the past 14 yr., is Secretary. W. Y. Stroh, of the Stroh Steel Hardening Process Co., is General Manager and Metallurgist.

Sales will be handled by C. Lee Straub and H. A. Johann for the Kennedy Mfg. & Engineering Dept.; John M. Sherrard and O. L. Mills for the Stroh Steel Hardening Process Dept.; W. H. Green for the Lawrence Steel Casting Dept.; B. Floersheim and J. W. Prenter for the Best Mfg. Dept.

The central plant, which is located in the heart of the Pittsburgh Mill District, was originally constructed by the late R. T. Crane, of Chicago, and is still considered a model factory. Extensive additions are being made, which, when completed, will give extensive facilities for high grade work and employment to not less than 2000 men and the corporation already has under contract for 1915 more than $1,000,000 worth of business.

FOR OPERATING the Calumet River bridge, South Chicago, Ill., a Bruce-Macbeth 200-hp., 4-cylinder engine is to be installed, operated on gasoline. This is an unusually large engine for gasoline operation; but, as it is used only for emergency service, the matter of fuel cost is not important. On the other hand, the engine must be ready to operate when necessary, and be sure that the fuel supply shall not fail from any cause. For use with this engine, a new carburetor and governing device were designed, have been tested out by the engineers for New York Central Railroad and for Wm. A. Pope, of Chicago, and found to work satisfactorily from no load up to 240 hp., without adjustment or missing fire. Double ignition is supplied, and compressed air starting equipment acting upon all cylinders in order to give quick starting.

SOME APPREHENSION has been felt in regard to the rise in the price of rubber products, on account of the embargo from foreign countries; but this embargo has now been lifted, and an official of the Goodyear Tire & Rubber Co., of Akron, O., states that this will probably prevent any advance in prices. High prices would have been inevitable if England had insisted on refusing to allow crude rubber from any of her possessions to be sent to the United States. The first receipt of rubber since the lifting of the embargo was a trainload of 23 cars carrying 500 tons which arrived in Akron, Jan. 22. There is also another 500 tons on board the Lusitania, due to arrive within a few days.

PIPE INSULATION for the new Utah State Capitol at Salt Lake City, for which R. K. A. Kletting was the architect, and Jas. C. Stewart Co., contractors, was recently ordered from the H. W. Johns-Manville Co. High pressure pipes will be covered with J-M Asbesto-Sponge Felted pipe covering, and heating pipes with J-M Asbestocel pipe covering.

THE GOULDS MFG. CO. has announced the opening of a new office in Atlanta, Ga., located in the Third National Bank Building and in charge of O. B. Tanner, district manager.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

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Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

ADVERTISING RATES

Display

Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year, each insertion, $20.00.

Eighth page, one year, each insertion, $12.00.

Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

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Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,000

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—Experienced engineer who understands both theory and practical operation of generators, steam and gas engines, and water purification, with technical education and 9 yr. practice in all lines, desires position in Middle West. Will furnish best of references, including present employer. Address Box 383, Practical Engineer, Chicago, Ill. 2-1-2

POSITION WANTED—By engineer, with first-class Canadian certificate, 14 years' experience. Familiar with any high speed, or Corliss engine; d.c. machines, air compressors, etc. Would take position as second in large power plant. Willing to go anywhere in Canada. Total abstainer. Excellent references. Address Box 378, Practical Engineer, Chicago, Ill. 2-15-1

POSITION WANTED—By Sales Engineer with wide experience in selling Steam Engines Boilers and Power Plant Equipment. Have shop experience and technical education. Can produce results. Address Practical Engineer, Box 379, Chicago, Ill. 2-15-1

POSITION WANTED—By engineer of 35, married, as fireman, assistant engineer or charge of small steam plant. Good repair man. Sober and steady. Will go anywhere in western states. Address Practical Engineer, Box 380, Chicago, Ill. 2-15-1

POSITION WANTED—As Chief Engineer of steam or hydro-electric power plant of 1000 hp. or less. 15 years' experience in central station operation; strictly temperate; best of reference as to character and ability. Middle West preferred. Address Box 376, Practical Engineer. 2-15-1

POSITION WANTED—As Chief Engineer and Electrician; 12 years' experience as chief engineer, electrician and erector of steam and electrical apparatus. Also some refrigerating experience. Age 29. Married. Strictly sober. Can furnish best of references. Can start Dec. 15th. Correspondence invited. S. James Zucchet, 1437 Solon Place, Chicago, Ill. 2-15-1

POSITION WANTED—By a young man at present holding a first-class fireman's license in Massachusetts. Understands repair work thoroughly. Will go anywhere in Middle West or Eastern states. Married, and can furnish best of references. Address Box 382, Practical Engineer, Chicago, Ill. 2-15-1

POSITION WANTED—In a modern plant where knowledge may be acquired. 3 yr. experience as fireman, oiler and switchboard operator. I. C. S. student. 30 yr. of age; married; abstainer and dependable. F. W. Beecroft, 3216 Fulton St., Chicago, Ill. 2-15-2

POSITION WANTED—By young man, age 21, as oiler or helper in power plant. A. S. C. graduate, electrical course. Some experience small gas engines. Would work a while for experience. Address O. W. House, Rush Springs, Okla. 2-15-1

POSITION WANTED—By engineer with years of experience in Ice and Electric Light Plants. Understand both A.C. and D.C. machines. Am a graduate of one of the best colleges in Middle West. A1 references. Ezra D. Dumas, Clarinda, Iowa. 2-15-1

POSITION WANTED—By student, fresh from University of Engineering. Desirous of getting into Mechanical, Electrical or Architectural Engineering. Some experience. Address A. W. Kelly, 5531 Lakewood Ave., Chicago, Ill. 2-1-2

POSITION WANTED—By young man, age 22, as Oiler or Assistant Engineer. I. C. S. graduate Steam-Electric course. 4 yr. experience as quarry Hoisting Engineer. Good reference. Oscar Malila, Troy, N. H. 2-15-1

POSITION WANTED—By young man, as wireman; 5 yr. experience. Reference. Can come March 1. Harold Howes, Williams, Iowa. 2-15-1

Wanted

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill. tf.

WANTED—Resident subscription agents in all cities of 50,000 population, and over. Many of the largest cities still open. An excellent chance for hustlers to turn their spare time into dollars. Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Agents to sell my Graduated Calipers, Pocket Levels, etc. Liberal commission. Ernst G. Smith, Tampa, Fla. 2-1-6

Help Wanted

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

For Sale

FOR SALE—Lippincott indicator, reducing wheel and planimeter, 40 and 60 springs. Like new. Carlos Robison, Fertile, Iowa. 2-15-1

FOR SALE—16x36 Watts Campbell (latest type), $500; 14x30 Hughes Phillips (latest type), $500; 14x16 Erie City automatic (latest type), $350; 12x36 Watts Campbell (latest type), $450. Duzets & Son, 50 Church St., New York, N. Y.

FOR SALE—Steam Hammer, 750 lb. Bement Niles; excellent condition; will sacrifice to move quick. Have large stock machinery of all kinds. Send us your inquiries. Zelnicker Supply Co., St. Louis, Mo. tf.

Patents and Patent Attorneys

PATENTS SECURED OR FEE RETURNED—Send sketch for free search, advice and report. Latest and most complete patent book ever published for free distribution. George P. Kimmel, Attorney, 226 Barrister Building, Washington, D. C. 12-15-6

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and report. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

ENGINEERS AND FIREMEN—Send 10c in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2238 Pope Ave., St. Louis, Mo. 10-1-6

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Some amazing revelations concerning advertising during war-time have recently come to our attention. A systematic series of tests conducted during the last six months by one of London's leading advertising consultants have revealed the startling fact that the results obtained from advertising per unit of expenditure are now as good as (and in some cases better than) those secured in peaceful times.

A large British advertising information bureau has been besieged with inquiries requesting information as to the proper media for advertising machinery — tools — furniture—musical instruments — stoves and mantles — leather goods — cycles — enameled hardware—electric lamps—motor car trimmings, etc., etc.

Particularly gratifying is the fact that scores of inquiries were received from non-advertising manufacturers whose products are of a nature entirely unaffected by the war. Many of the inquiries requested information regarding advertising matter. Requests by the score were received for the addresses of makers of advertising novelties, silk flags, cutouts, cardboard window models, advertising mirrors, tablets, frames, etc.

There is an increased demand for printed matter of all kinds, such as booklets, catalogs, etc. A new London paper, the Daily Call, made its initial appearance October 5th. Its publishers claim that no special efforts have been made to secure advertising, yet its pages have been well occupied with the announcements of various manufacturers.

"Business As Usual" is the slogan adopted by British merchants.

All this should be mighty interesting to Americans. Surely, if one of the belligerent countries in the throes of the greatest calamity since the beginning of history can foster such a spirit, we, a peaceful nation, should emulate its example with a more intensified brand of business optimism.

We can all profit from the past six months' experience of Great Britain.

The results of the above-mentioned tests are vitally important to us. They prove the value of **Confidence.**

To manufacturers these results are of paramount importance, as the fundamental function of advertising is to create **Confidence**—the whole history of manufactured products from the original conception to the final marketing is based on **Confidence.**

To the consumer **Confidence** is everything —it is vitalized by the desire of the manufacturer to make public the ability of his product to meet the demands. He must have **Confidence** in his product induced by the actual results already obtained or he would not advertise, is the logical deduction of the consumer.

That's why it pays to buy advertised goods. And why you are safe-guarded from uncertainty, experiment, and inefficiency.